GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[x] ORIGINAL [ ] REVISION NO. _____

Project No. A-3291 DATE 7/16/82

Project Director: James L. Burson School/Lab EDL/SHS

Sponsor: City of Greenville, South Carolina

Type Agreement: GTRI Research Project Agreement

Award Period: From 7/14/82 To 9/15/82 (Performance) 9/15/82 (Reports)

Sponsor Amount: $2,550 Contracted through:

Cost Sharing: GTRI/~~GIT~~

Title: Air and Bulk Asbestos Sampling and Analysis

ADMINISTRATIVE DATA

OCA Contact Faith G. Costello

1) Sponsor Technical Contact:

SAME

2) Sponsor Admin/Contractual Matters:

Jack Howley
Assistant City Manager
City of Greenville, S.C.
P.O. Box 2207
Greenville, S.C. 29602

Defense Priority Rating: N/A

Security Classification: N/A

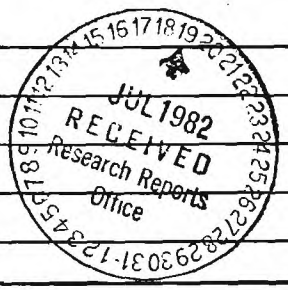
RESTRICTIONS

See Attached N/A Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval – Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with N/A

COMMENTS:



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Computer Input
Project File
Other _____

FORM OCA 4:781

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION SHEET

Date 12/22/82

Project Title: Air and Bulk Asbestos Sampling and Analysis

Project No: A-3291

Project Director: William M. Ewing

Sponsor: City of Greenville, South Carolina

Effective Termination Date: 9/18/82

Clearance of Accounting Charges: 9/15/82

Grant/Contract Closeout Actions Remaining:

- [x] Final Invoice ~~and Closing Documents~~
- [ ] Final Fiscal Report
- [ ] Final Report of Inventions
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other _____

Note: Budget was increased to $2,674.92 total, via budget amendment dated 12/22/82.

Assigned to: EDL/SHD (~~School~~/Laboratory)

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FORM OCA 10:781

ASBESTOS SURVEY
for
CITY OF GREENVILLE, SOUTH CAROLINA

Project No. A-3291

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Atlanta, Georgia
August 10, 1982

ASBESTOS SURVEY
for
CITY OF GREENVILLE, SOUTH CAROLINA

1.0 INTRODUCTION

The Georgia Tech Research Institute was retained by Mr. Jack Howly of the City of Greenville, South Carolina to perform an investigation for asbestos at City Hall located at 206 S. Main Street, Greenville, South Carolina. This investigation was performed on July 15-16, 1982 by Mr. William M. Ewing of Georgia Tech. While at the facility he was accompained by Messrs. George McDaniel and Charles. The purpose of the survey was to determine the hazard potential created by asbestos-containing fireproofing in the city hall building. The following report summarizes the results of this study including conclusions and recommendations.

2.0 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are derived from the bulk and air sampling data, observations of the investigator, and interviews with City of Greenville managerial personnel.

2.1 CONCLUSIONS

2.1.1 The sprayed-on fireproofing present on the structural members (and any overspray) contains the chrysotile form of asbestos. The percent chrysotile in the fireproofing as measured by polarized light microscopy ranged from 5-10 percent.

2.1.2 Air sampling (area) conducted during normal building activities indicated fiber concentrations from less than 0.01 to 0.03 fibers* per cubic centimeter of air (fibers*/cc), determined as 8-hour, time-weighted averages (TWAs).

2.1.3 Air samples taken during maintenance activities (personal and area) indicated a significant increase in airborne fiber* concentrations in the room where the maintenance work occurred. Fiber* concentrations were measured as high as 0.45 fibers*/cc for a 10-minute sample.

2.1.4 Limitations in the phase contrast method of analysis do not permit us to speculate on fiber concentrations which contain fibers shorter than 5 micrometers or thinner than approximately 0.3 micrometers. It is probable that these smaller fibers are present in the workplace air.

2.1.5 Under the current procedures used during maintenance activities involving work above the suspended ceiling or disturbing settled dust, maintenance personnel are exposed to fibers* above the Occupational Safety and Health Administration's definition of exposure to asbestos (0.1 fibers*/cc, 8-hour, TWA).

*greater than 5 micrometers in length

2.1.6 City and Water Department employees present in areas where above the ceiling maintenance was occurring may have been exposed to elevated concentrations of asbestos fibers.

2.2 RECOMMENDATIONS

2.2.1 Notify all maintenance personnel or others including contractor, telephone, and elevator repair personnel of the potential hazard associated with the asbestos-containing fireproofing.

2.2.2 Post warning signs on the penthouse doors, storage room doors (basement level), telephone rooms (inside) and any other locations where asbestos-containing fireproofing may be disturbed. Specifications for these signs are included in the OSHA standard (See Appendix E).

2.2.3 Building occupants should be notified of the presence of asbestos-containing fireproofing above the suspended ceiling. All occupants should be instructed never to disturb any ceiling tiles. The occupants should also be informed as to what protective measures are being taken to protect them. Informing the building occupants should come from the highest administratve official.

2.2.4 A committee should be established to evaluate alternative solutions and provide recommended actions as necessary. This committee should select one person to be designated the Asbestos Coordinator.

2.2.5 The Asbestos Coordinator will oversee all activities concerning the fireproofing including any abatement procedures, public relations, recordkeeping, etc.

2.2.6 Obtain legal council regarding potential liabilities resulting from asbestos-related problems. This person (firm) may serve as a member of the committee.

2.2.7 Obtain the guidance of an architect regarding building codes, fire codes, etc. that must be considered during any asbestos abatement activities.

2.2.8 The Environmental Protection Agency (EPA) Asbestos Standard (40 CFR 61.20, see Appendix F) requires that the asbestos-containing fireproofing be removed prior to demolition (or renovation involving greater than 160 square feet) of the building. Removal of the material properly can greatly reduce the risk for building occupants. For these reasons we recommend that removal of all asbestos-containing fireproofing be considered.

2.2.9 Should total removal be deemed not feasible by the City of Greenville then partial removal should be accomplished. The highest priority should be put on the removal of all fireproofing from the elevator shafts and return air chases. The second priority should include removal from the basement level maintenance shop and penthouse level. All other areas where material is exposed should then be enclosed. This would include the city and water department record's rooms, power vault, transformer room, and electrical rooms on each floor. A suspended ceiling or other enclosure (permitted by local fire safety codes) would reduce the amount of asbestos fallout into the workplace air.

2.2.10 Until such time that the fireproofing is removed from the building standard operating procedures should be established to protect building occupants from exposure during maintenance activities by in-house or contractor personnel. These procedures should require at minimum the following:

1) Notification of the Asbestos Coordinator before any maintenance work (above the ceiling tile or otherwise expected to create asbestos-containing dust) begins.

2) The air handling system from the work area should be shut down and sealed before work begins.

3) The work area should be physically isolated from all other areas (barriers constructed of polyethylene plastic work well for this).

4) Warning signs should be posted at all entrances and exists to the work area.

5) The work area should have no openings where air containing asbesots might escape.

6) The floor should be covered with plastic (minimum 6 mil) to protect it from asbestos contamination and water damage.

7) All movable items should be removed from the work area and stationary items sealed in plastic.

8) All work practices should include wet methods to minimize the generation of asbestos-containing dust.

9) No mechanized equipment should be used in direct contact with the fireproofing unless equipped with HEPA* filtered local exhaust.

10) All workers or other persons entering the work area must wear respiratory protection approved for use in atmospheres containing asbestos by the National Institute for Occupational Safety and Health (NIOSH). Note: Disposable respirators will not offer enough protection under most circumstances.

11) All personnel required to wear a respirator will need to be enrolled in a respiratory protection program which meets the specifications of the OSHA standard (29 CFR 1910.134, see Appendix G).

12) All persons entering the work area should wear appropriate full body protective covering. (Disposable coveralls work well for this purpose).

13) Waste should be bagged while wet.

14) All waste generated should be bagged and labeled according to EPA and OSHA and disposed of at an approved landfill.

15) Upon completion of work all surfaces should be vacuumed with a HEPA filtered vacuum or wet-wiped. After waiting 24 hours for dust to settle this should be repeated.

16) Air sampling should be conducted during and immediately following maintenance activities which might disturb the fireproofing or settled dust. This should include personal samples for the workers and area samples immediately outside the work area. Upon completion of final clean-up additional air samples must be taken.

*HEPA - high efficiency particulate absolute

17) All air sample results should be reported to the Asbestos Coordinator within 24 hours in order that appropriate action can be taken if needed.

18) The standard operating procedures must be strictly enforced for building personnel and contractor personnel.

2.2.11 All building maintenance personnel should be provided with annual physical examinations as required by the OSHA standard (see Appendix E).

2.2.12 All medical and air monitoring records must be maintained for a period of at least 30 years.

2.2.13 Should the decision be made not to remove the fireproofing then a maintenance plan should be established and records retained. This plan should include at a minimum:

1) Semi-annual inspection of the condition of the fireproofing (integrity, friability, etc.)

2) Inspection of any areas subject to water damage or disturbed for any reason.

3) Remove settled dust from tops of ceiling tiles and bottom of elevator shafts and return air shafts if this material has not been removed.

4) Perform annual air sampling throughout the facility. Future air sampling should allow for electron microscopy analysis to more accurately assess the degree of hazard.

5) Maintain all records.

3.0 BUILDING DESCRIPTION

The Greenville, South Carolina city hall is located at 206 South Main Street, Greenville, South Carolina. The building consists of 12 levels designated the basement, floors 1-10, and the penthouse. The total estimated floor space is 96,000 square feet. The building houses city government offices and offices of the water works department. Sprayed-on fireproofing is present at all levels on structural members with significant overspray metal corrugated on the deck, pipes, worklight wiring, conduit and ductwork. The depth of the fireproofing is from three-quarters to one and one-half inches. The appearance of the fireproofing is similar throughout the facility and grey in color. The floor plans for this building have been included in Appendix C of this report.

3.1 FLOORS ONE THROUGH TEN

Levels one through ten house offices for the city and the water department. Computer rooms are located on floors three and four. On each level there is a suspended accoustic tile ceiling concealing the deck except in the telephone and/or janitorial closets where the suspended ceiling may be absent.

*greater than 5 micrometers in length

Floors one through nine and the basement utilize the void between the ceiling tiles and the deck as a return-air plenum. Supply-air is ducted through the troffers of the light fixtures. Return-air on each floor returns to either the east or west return-air chase which rises to the penthouse. These chases are simple voids in the building and therefore contain fireproofing on structural members. Air from these chases combine in the penthouse mixing box, combine wih fresh air and is returned via ducts to the office areas. The air handling system for the 10th floor is separate from the remainder of the building but utilizes the return air plemum system similar to other floors.

3.2 BASEMENT

Many rooms in the basement have a suspended tile ceiling. Those rooms that do not include the maintenance shop, high-voltage equipment room, water department records room and city records storage room. The telephone equipment room had eight ceiling tiles missing or damaged.

3.3 PENTHOUSE

The penthouse houses all air handling equipment and the elevator equipment room. Fireproofing is exposed throughout the penthouse level and in each of the four elevator shafts (two shafts are in use and two are vacant).

4.0 DISCUSSION OF FINDINGS

4.1 SURVEY PROTOCOL

The survey was designed to confirm the presence of asbestos (chrysotile) in the fireproofing followed by air sampling to estimate fiber* concentrations at selected locations under different conditions. It should be emphasized that the analytical method employed (National Institute for Occupational Safety and Health (NIOSH) method P & CAM 239) cannot measure fibers shorter than 5 micrometers in length nor thiner than approximately 0.3 micrometers. It is these small fibrs that may pose the greatest threat to the health of persons exposed via inhalation. To measure these fibers would require analyses by electron microscopy which was prohibited due to the cost of such analyses (approximately $300-500 per sample).

4.2 BULK SAMPLING

Five bulk samples of fireproofing were collected from the basement, 3rd, 6th, and 9th floors, and the penthouse. Each of these samples were analyzed by polarized light microscopy (PLM) to determine the type and approximent content of asbestos. The results of analyses have been reported in Apendix A, Table A-1 of this report. The type of asbestos identified in each sample was chrysotile and the percent (by volume) ranged from 5 to 10%.

*greater than 5 micrometers in length

4.3 AIR SAMPLING, JULY 15, 1982

Twelve air samples were collected at selected locations throughout the building and one sample outside the building on the roof. Fibers* were present only in the twelve samples collected inside the building. The range of concentrations was from less than 0.01 to 0.03 fibers* per cubic centimeter of air (fibers*/cc). Although these concentrations are below the current Occupational Safety and Health Administration (OSHA) permissable exposure limit (PEL) and the current NISOH recommended limit, any exposure (through inhalation) to asbestos fibers should be considered a potential threat to those exposed.

The highest fiber* concentration was found in the elevator equipment room. This was probably due to the action of the elevators as they passed through the shafts containing fireproofing. Observations within these elevator shafts depicted damaged fireproofing and fireproofing on the floor of the shafts. Loose fireproofing was also noted on the floor of the two return-air shafts at the basement level.

4.4 AIR SAMPLING, JULY 16, 1982

Fourteen personal and area air samples were collected on July 16, 1982. On this day of sampling limited maintenance activities occurred for 66 minutes during the morning hours. Personal and area air samples were collected in and around the work area (seventh floor, southwest corner). Additional area air samples were collected on selected floors throughout the day.

Personal samples collected in the breathing zone of the employee performing the maintenance activities indicated an airborne fiber concentration of 0.14 and 0.45 fibers*/cc. The higher concentration was found during removal of ceiling tiles. Area sampling conducted in the southwest corner of the seventh floor during work indicated 0.14 fibers*/cc. Area samples collected immediately outside the work area on the seveth floor indicated 0.01 and 0.02 fibers*/cc, respectively. One area sample was collected after all work was complete indicated 0.04 fibers*/cc, indicating fibers* remain in the air after work is completed. There was no significant increase in fiber* concentrations in nine samples collected throughout the remainder of the facility with the exception of one sample taken on the third floor. It is probable that this increase in fibers* was due to a reorganization of furniture during the sampling period. Such activities will entrain settled fibers* back into the air.

The results of personal air samples indicated values in excess of the NIOSH recommended exposure limit of 0.1 fibers*/cc. These samples also indicated that persons performing routine and non-routine maintenance activites above the suspended ceiling will be exposed to fiber* concentrations above the 0.1 fibers/cc definition of "exposure" by OSHA. Other persons in the work area and immediately surrounding areas will also be exposed to increased fiber concentrations.

*greater than 5 micrometers in length

ASBESTOS EXPOSURE ALGORITHM

Location City Hall, 206 S. Main Street, Greenville, S.C.

Investigator William M. Ewing Date July 16, 1982

FACTORS	RANGE OF SCALE	Building Area and Selected Value: Floors 1-10	Penthouse	Basement Work Shop	Elevator Shaft
1. Material Condition (Deterioration)					
None (No damage)	0	0	0	0	5
Moderate (small area)	2				
Wide spread damage	5				
2. Water Damage					
None	0				
Minor	1	0	1	1	1
Moderate/Major	2				
3. Exposed Surface Area					
No exposed area	0				
10% of area or less	1	0	4	4	4
10% - 100%	4				
4. Accessibility					
Not accessible	0				
Low-rarely accessible	1	0	1	4	0
Moderate/High accessibility	4				
5. Activity/Movement					
None/low (library)	0				
Moderate (classrooms)	1	1	1	1	2
High (Gyms, Cafeterias)	2				
6. Air Plenum/Direct Air Stream					
None	0	1	1	1	1
Present	1				
7. Asbestos Content					
Trace - 1%	0				
1% - 50%	2	2	2	2	2
50% - 100%	3				
8. Friability					
Low (Difficult to damage)	1				
Moderate (Easy to damage)	2	2	2	2	3
Highly friable (Flaking, hanging)	3				
9. Algorithm					
Add Factor Scores 1-6 (1+2+3..etc) = sum		2	8	15	13
Multiply Factor Scores 7,8 (7x8-=product)		4	4	4	6
Multiply above Sum by above Product					
Corrective Action Exposure Index		8	32	60	78

Recommendations-Corrective Action Scale Index: 0-12 = no immediate problem ____; 10-50= Consider some control measure ____; 40-up = Remove material in order of score; high indexes first ____.

Comments: _____

Table 4.0-1

ASBESTOS EXPOSURE ALGORITHM

Location City Hall, 206 S. Main Street, Greenville, S.C.

Investigator William M. Ewing Date July 16, 1982

FACTORS	RANGE OF SCALE	Building Area and Selected Value: Basement Records Room	Return Air Shaft		
1. Material Condition (Deterioration)					
None (No damage)	0				
Moderate (small area)	2	0	2		
Wide spread damage	5				
2. Water Damage					
None	0				
Minor	1	1	0		
Moderate/Major	2				
3. Exposed Surface Area					
No exposed area	0				
10% of area or less	1	4	4		
10% - 100%	4				
4. Accessibility					
Not accessible	0				
Low-rarely accessible	1	4	0		
Moderate/High accessibility	4				
5. Activity/Movement					
None/low (library)	0				
Moderate (classrooms)	1	0	2		
High (Gyms, Cafeterias)	2				
6. Air Plenum/Direct Air Stream					
None	0	1	1		
Present	1				
7. Asbestos Content					
Trace - 1%	0				
1% - 50%	2	2	2		
50% - 100%	3				
. Friability					
Low (Difficult to damage)	1				
Moderate (Easy to damage)	2	2	2		
Highly friable (Flaking, hanging)	3				
Algorithm					
Add Factor Scores 1-6 (1+2+3..etc) = sum		10	9		
Multiply Factor Scores 7,8 (7x8-=product)		4	4		
Multiply above Sum by above Product					
Corrective Action Exposure Index		40	36		

commendations-Corrective Action Scale Index: 0-12 = no immediate problem ____; 10-50= sider some control measure ____; 40-up = Remove material in order of score; high indexes t ____.

iments: _____

Table 4.0-2

4.5 SAWYER ALGORITHM

The Sawyer algorithm was calculated for selected areas of the building based on the observations of the investigator. The results of the algorithm calculations are included in Tables 4.0-1 and 4.0-2. This algorithm is utilized by school systems as a tool for assessing the potential asbestos hazard. The algorithm should not be used alone but only in conjunction with other observations and data in formulating recommendations for asbestos-containing fireproofing.

The results of the algorithm indicate that the most serious problems exist in the elevator shaft, return-air shafts, and the basement workshop. The area of least concern, based solely on the algorithm, are the occupied floors with suspended tile ceilings. The conclusions and recommendations appearing in Section 2.0 of this report include the data obtained from the Sawyer algorithm.

This Report Prepared By:

William M. Ewing
Industrial Hygienist

This Report Approved By:

James L. Burson, Program Manager
Occupational Safety and Health
Consultation Program

WME:JLB:sek

APPENDIX A

RESULTS OF BULK SAMPLE ANALYSES

RESULTS OF BULK SAMPLE ANALYSES

for

City of Greenville, South Carolina

Sample Description	Analytical Results Asbestos (yes or no)	Comments
B-2, penthouse elevator room	yes	10% chrysotile in vermiculite
B-3, basement maintenance shop	yes	10% chrysotile in vermiculite
B-4, 3rd floor electrical room	yes	5% chrysotile in vermiculite
B-5, 6th floor electrical room	yes	5% chrysotile in vermiculite
B-6, 9th floor electrical room	yes	10% chrysotile in vermiculite

APPENDIX B

RESULTS OF AIR SAMPLING

Table A-1

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Safety & Health Services

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant City Hall Building
206 S. Main Street, Greeville, S.C.

Materials Fibers greater than 5 micrometers in length.

Date 1982	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration	
			Start	Stop			Fibers per Filter	Fibers per cc Air
7/15	AA-79	Area sample, on roof, outside east penthouse door	0809	1625	982	496	<3,000	<0.01
7/15	AA-73	Area sample, penthouse, top of electric boiler	0811	1627	972	496	18,000	0.02
7/15	AA-69	Area sample, penthouse, west side of elevator room	0813	1629	987	496	28,000	0.03
7/15	AA-87	Area sample, 10th floor, center of east side, kitchen	0818	1640	994	502	10,000	0.01
7/15	AA-64	Area sample, 8th floor, center of south side, open office bay	0821	1643	1010	502	14,000	0.01
7/15	AA-74	Area sample, 7th floor, SW corner in open office bay	0828	1718	1080	530	4,000	<0.01
7/15	AA-65	Area sample, 5th floor, west end cafeteria, under ceiling grill	0833	1709	1040	516	17,000	0.02
7/15	AA-71	Area sample, 3rd floor, SE corner east of computer room	0837	1654	1010	497	8,000	<0.01
7/15	AA-56	Area sample, 2nd floor, center S side, under air supply vent	0841	1716	1050	515	14,000	0.01
7/15	AA-70	Area sample, 1st floor, lobby, SW corner by plant	0845	1648	980	483	8,000	0.01
7/15	AA-63	Area sample, basement, room B-09 records storage room	0849	1723	1040	514	4,000	<0.01
7/15	AA-59	Area sample, basement, SE corner of building, workshop	0853	1658	960	485	10,000	0.01
7/15	AA-62	Area sample, basement, NW corner of building, water department	0857	1714	994	497	7,000	<0.01

Table A-2

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Safety & Health Services

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant City Hall Building
206 S. Main Street, Greenville, SC

Materials Fibers greater than 5 micrometers in length.

Date 1982	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration	
			Start	Stop			Fibers per Filter	Fibers per cc air
7/16	AA-57	C. Barker, removed 3 ceiling panels and moved light fixture	1004	1100	111	56	15,000	0.14
7/16	AA-19	C. Barker, removed 6 ceiling panels and replaced same	1100	1111	22	11	10,000	0.45
7/16	AA-54	Area sample, 7th floor, SW corner during maintenance activity	1005	1111	134	66	18,000	0.14
7/16	AA-58	Area sample, 7th floor, in hall outside door to work area	1000	1606	732	366	14,000	0.02
7/16	AA-88	Area sample, 7th floor, south of work area in personnel office	1002	1605	730	363	8,000	0.01
7/16	AA-90	Area sample, 7th floor, work area, after work completed	1115	1606	591	291	22,000	0.04
7/16	AA-55	Area sample, 6th floor, SW corner (below work area)	0846	1619	888	453	11,000	0.01
7/16	AA-52	Area sample, 8th floor, center of south side (above work area)	0843	1616	906	453	7,000	<0.01

Table A-3

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Safety & Health Services

INDUSTRIAL HYGIENE SAMPLING SUMMARY

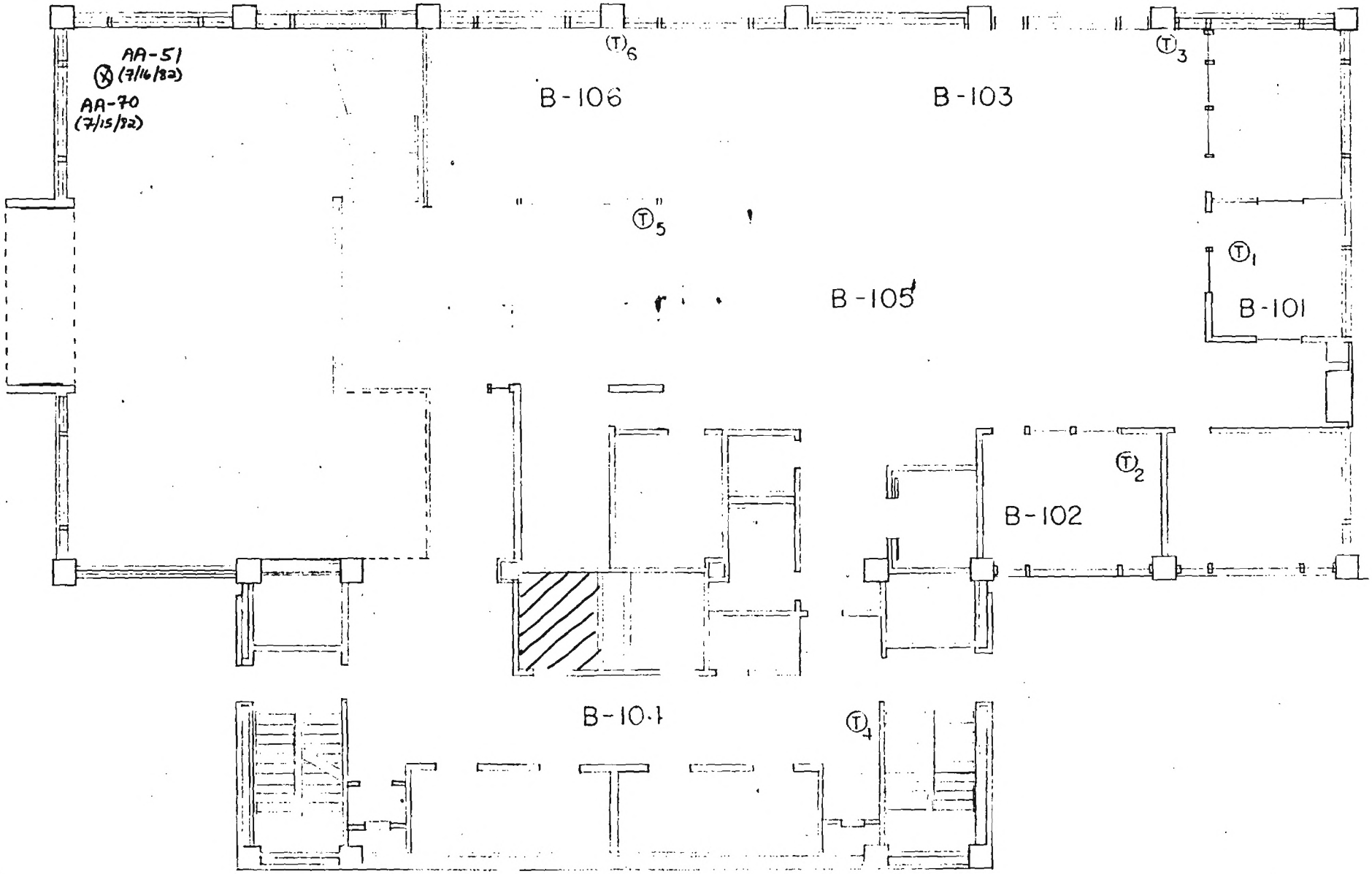
Plant City Hall Building
206 S. Main Street, Greenville, SC

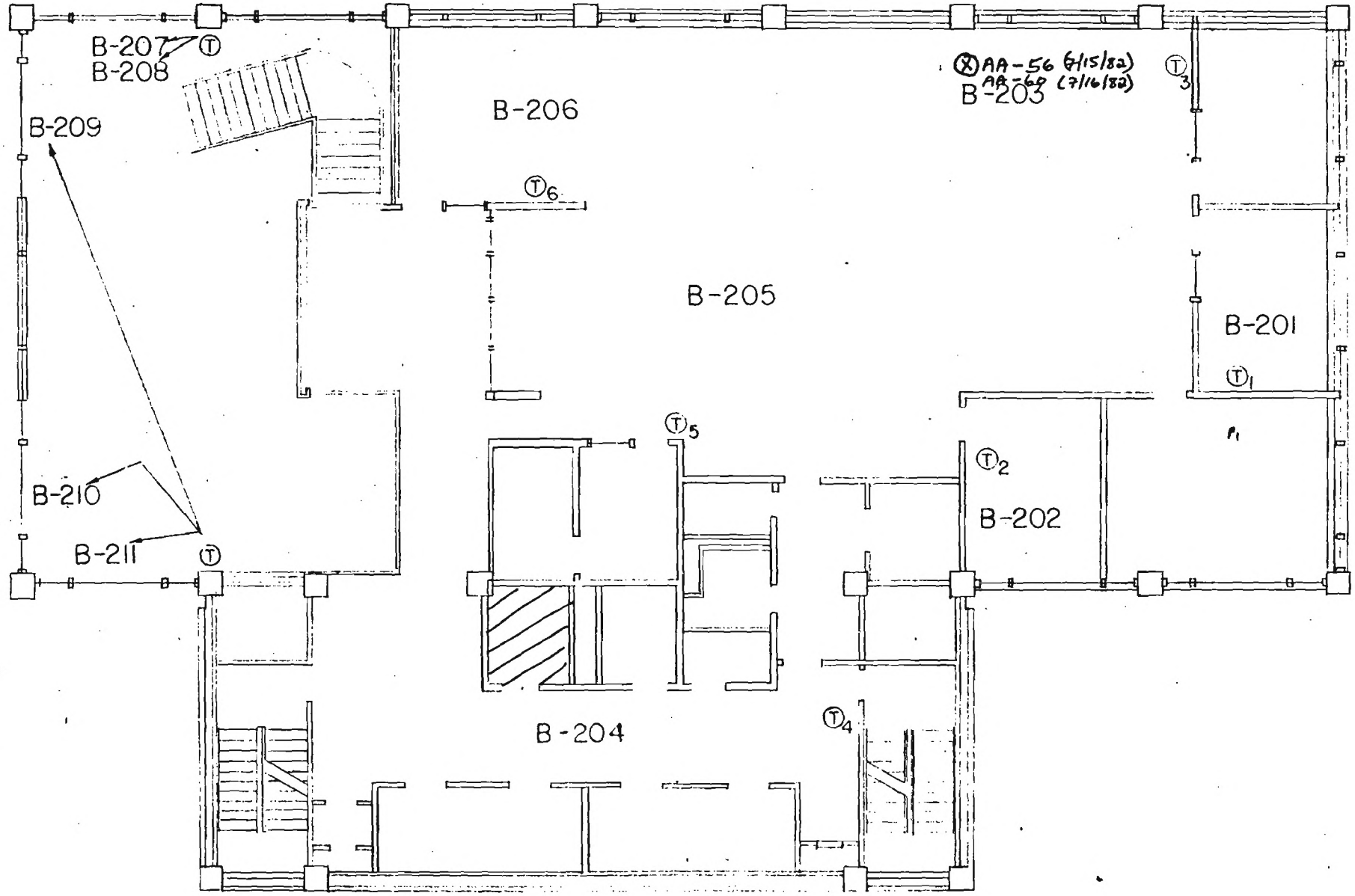
Materials Fibers greater than 5 micrometers in length

Date 1982	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration	
			Start	Stop			Fibers per Filter	Fibers per cc Air
7/16	AA-78	Area sample, building superintendent's office, basement level	0816	1548	895	452	13,000	0.01
7/16	AA-51	Area sample, lobby, SW corner next to plant	0856	1628	918	452	6,000	<0.01
7/16	AA-60	Area sample, 2nd floor, center of south side	0854	1625	897	451	<3,000	<0.01
7/16	AA-72	Area sample, 3rd floor, SE corner, east of computer room	0851	1622	909	452	34,000	0.04
7/16	AA-82	Area sample, 10th floor, center of south side	0843	1616	924	453	7,000	<0.01
7/16	AA-77	Area sample, penthouse, top of electric boiler	0836	1611	892	455	14,000	0.02

APPENDIX C

FLOOR PLANS, 206 S. MAIN STREET, GREENVILLE, S.C.


AA-51
(7/16/82)
AA-70
(7/15/82)
T6
T3
B-106
B-103
T5
T1
B-105
B-101
T2
B-102
B-10-1
T4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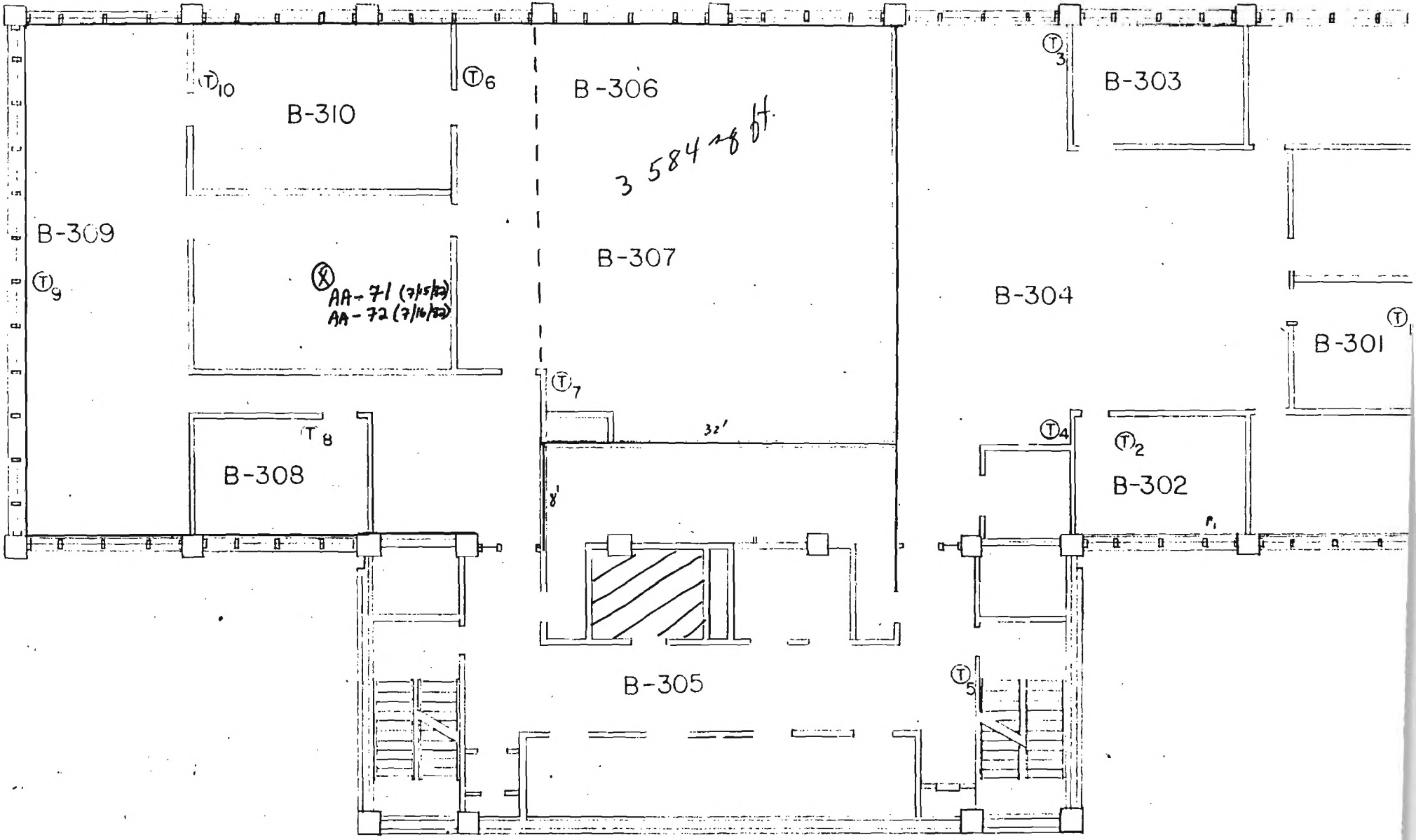
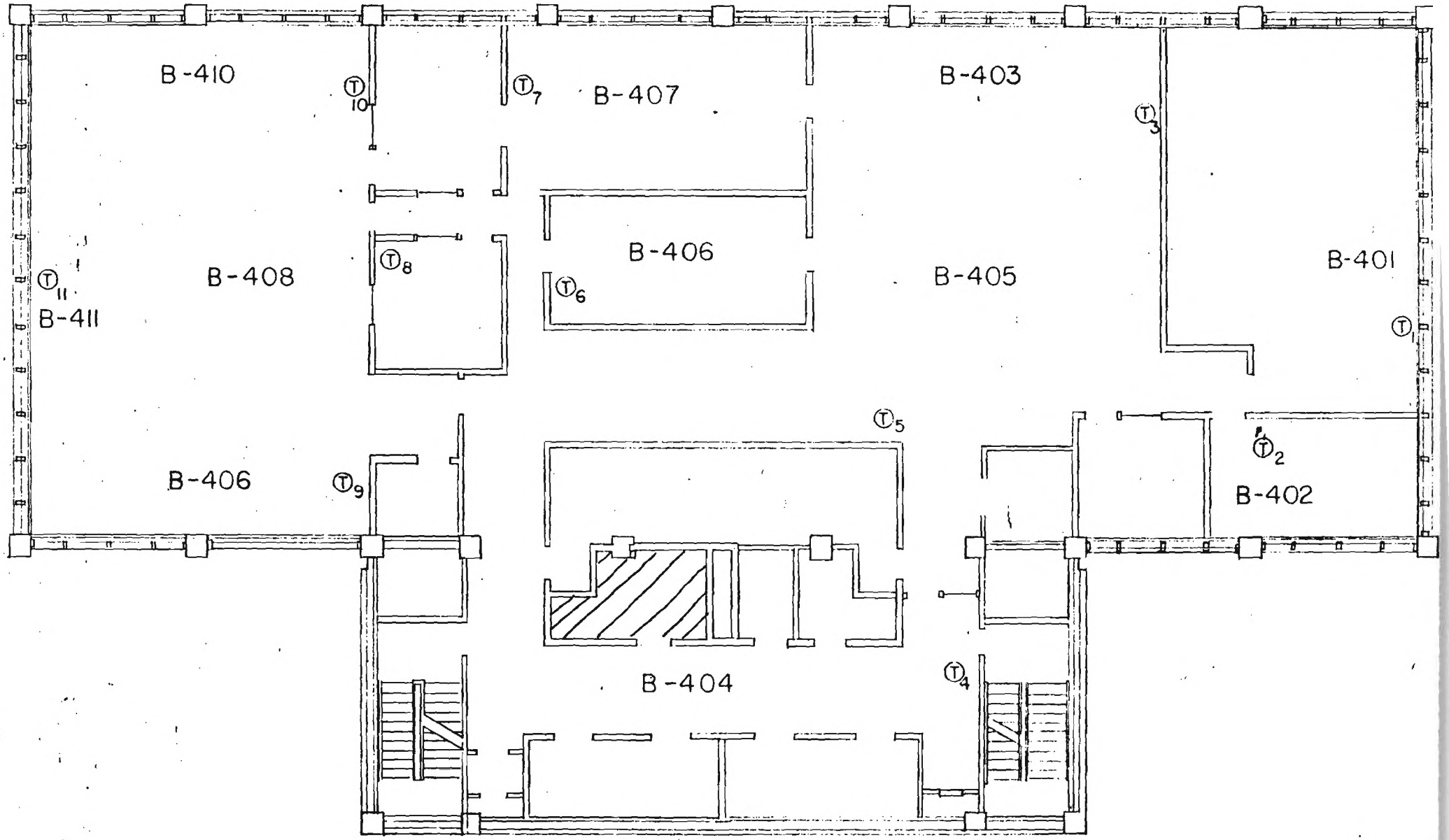
AA-56 (7/15/82)
AB-69 (7/16/82)
T1
T2
T3
T4
T5
T6


T10
T6
B-310
B-306
3584 sq ft.
T3
B-303
B-309
T9
X
AA-71 (7/15/82)
AA-72 (7/16/82)
B-307
B-304
B-301
T7
32'
T8
B-308
8'
T4
T2
B-302
B-305
T5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T10
T7
B-407
B-403
T3
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T8
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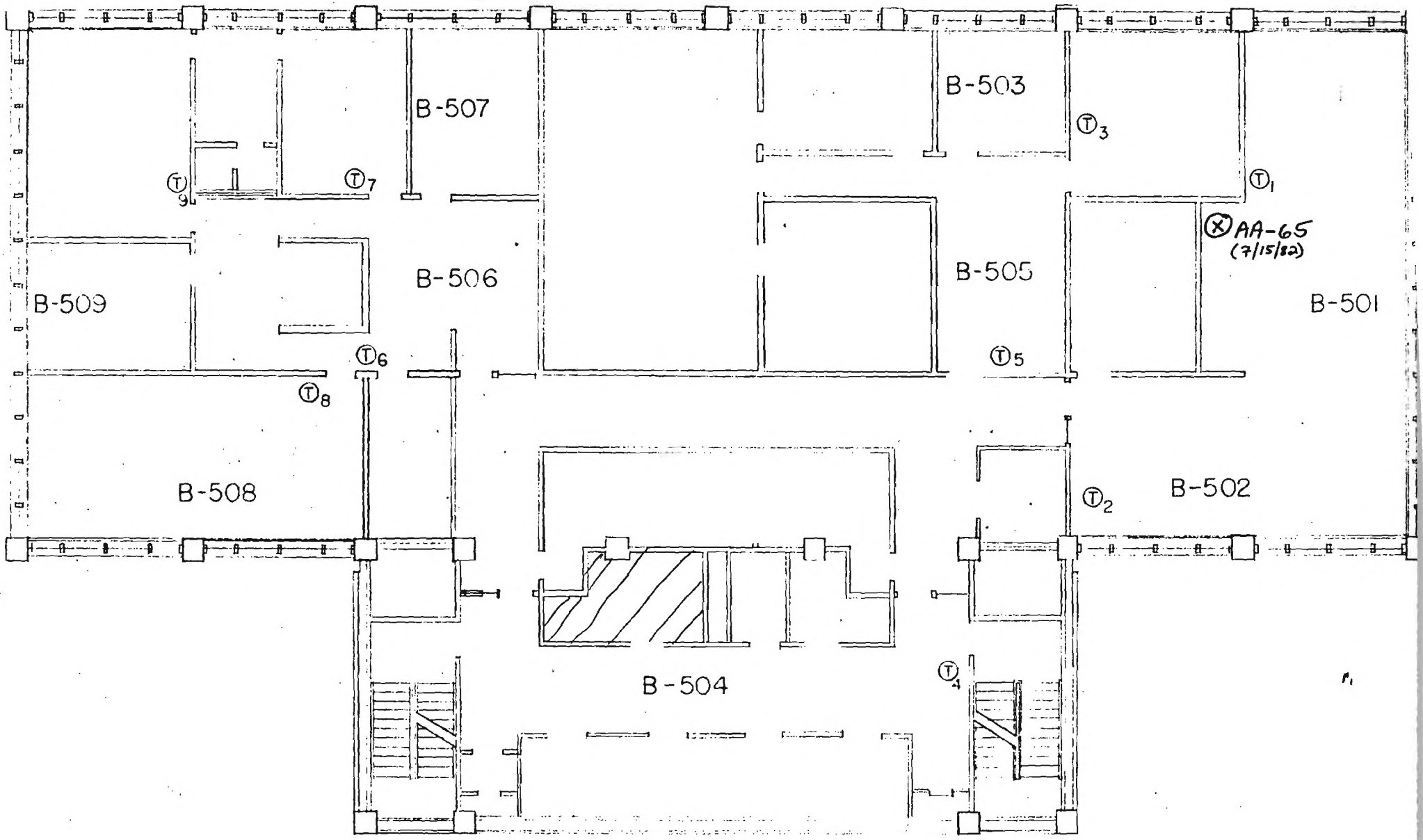
T2
B-406
T9
B-402
B-404
T4


B-507
B-503
T3
T1
T9
T7
AA-65
(7/15/82)
B-509
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B-505
B-501
T6
T5
T8
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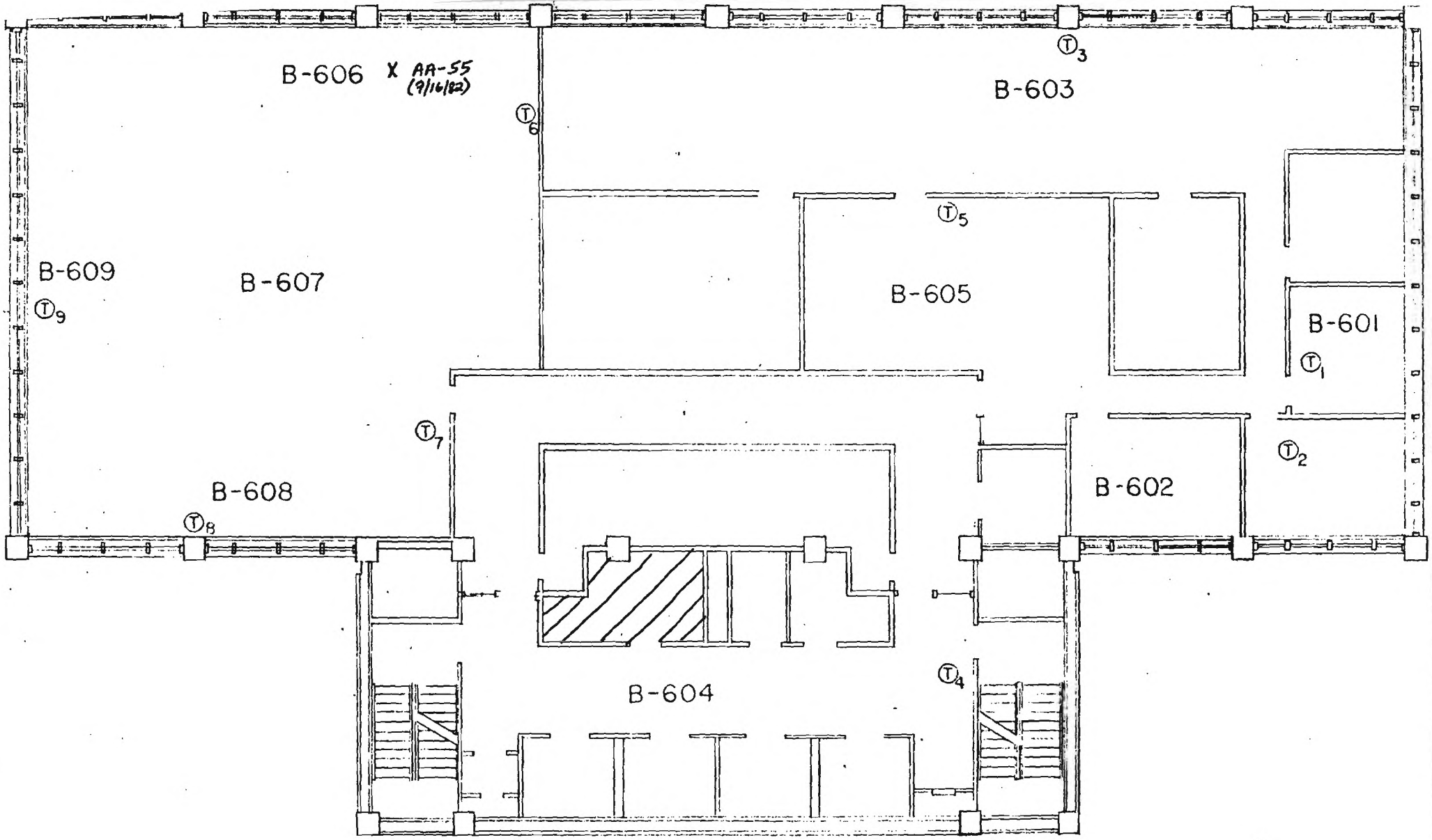
T2
B-502
B-504
T4


B-606 X AA-55 (9/16/82)
T6
T3
B-603
T5
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T8
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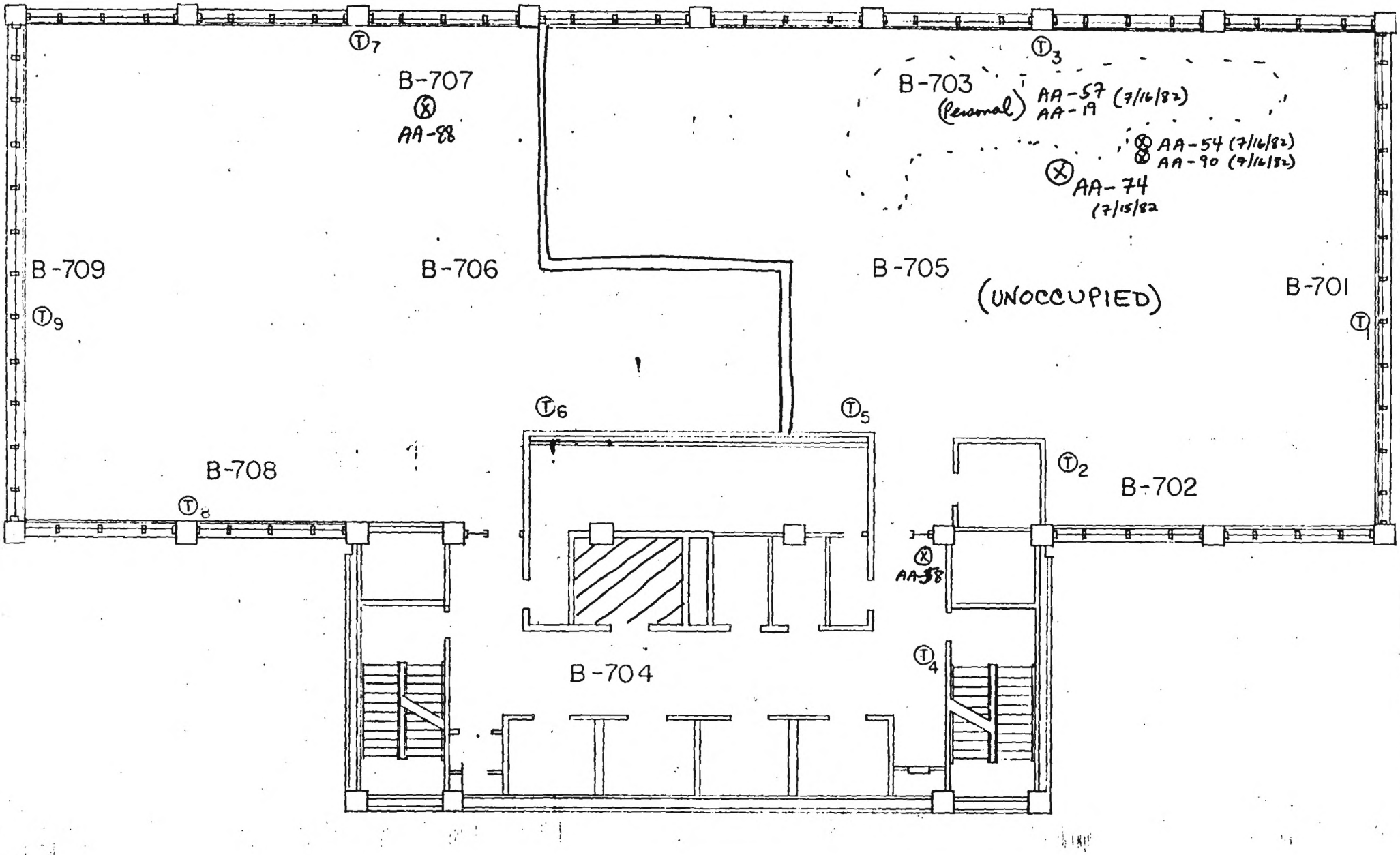
B-604
T4


T7
B-707
AA-88
T3
B-703
(personal)
AA-57 (7/16/82)
AA-19
AA-54 (7/16/82)
AA-90 (7/16/82)
AA-74
(7/15/82
B-709
B-706
B-705
(UNOCCUPIED)
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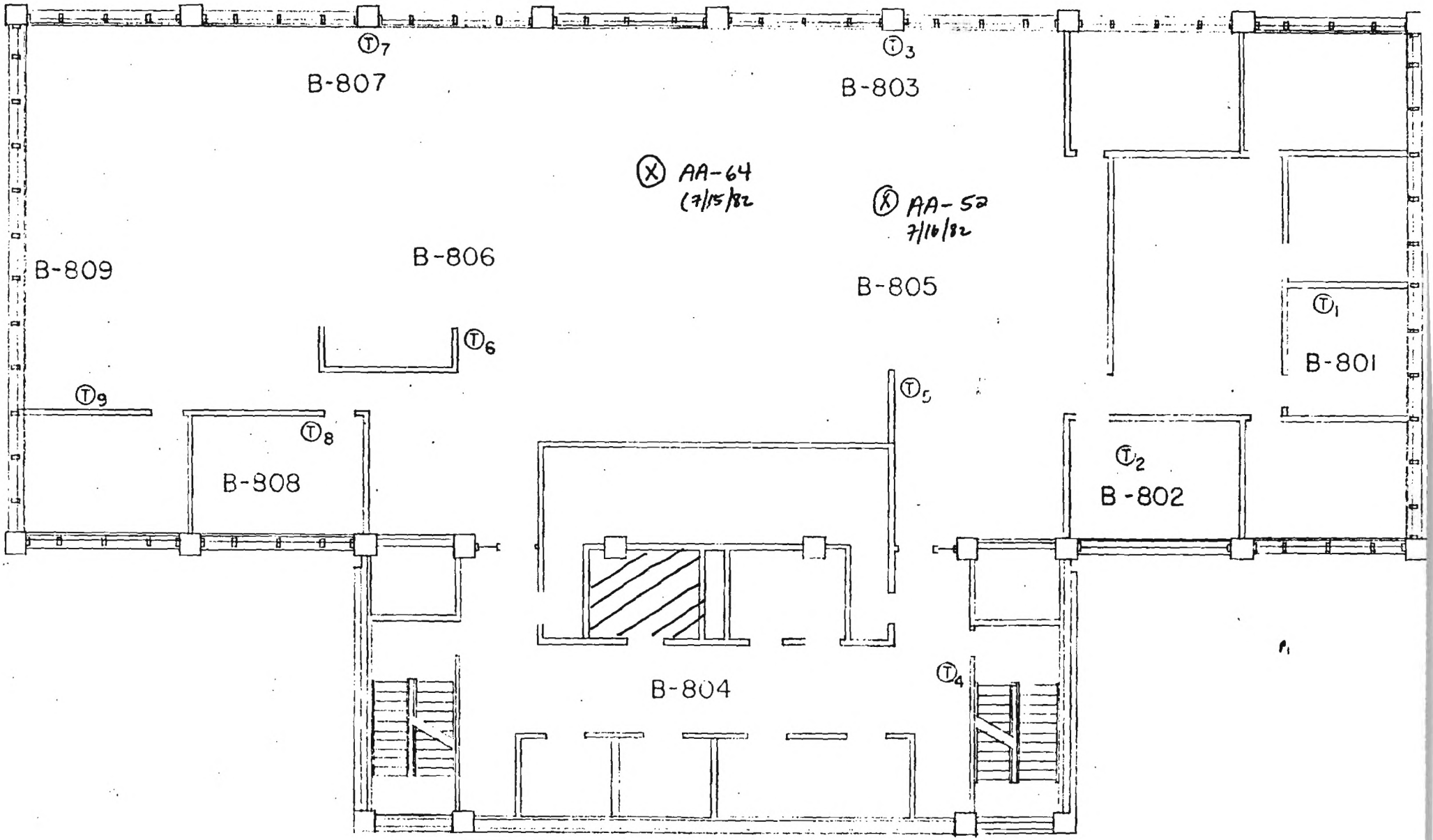
T4
B-704


T7
B-807
T3
B-803
X AA-64
(7/15/82
X AA-52
7/16/82
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T1
B-801
T6
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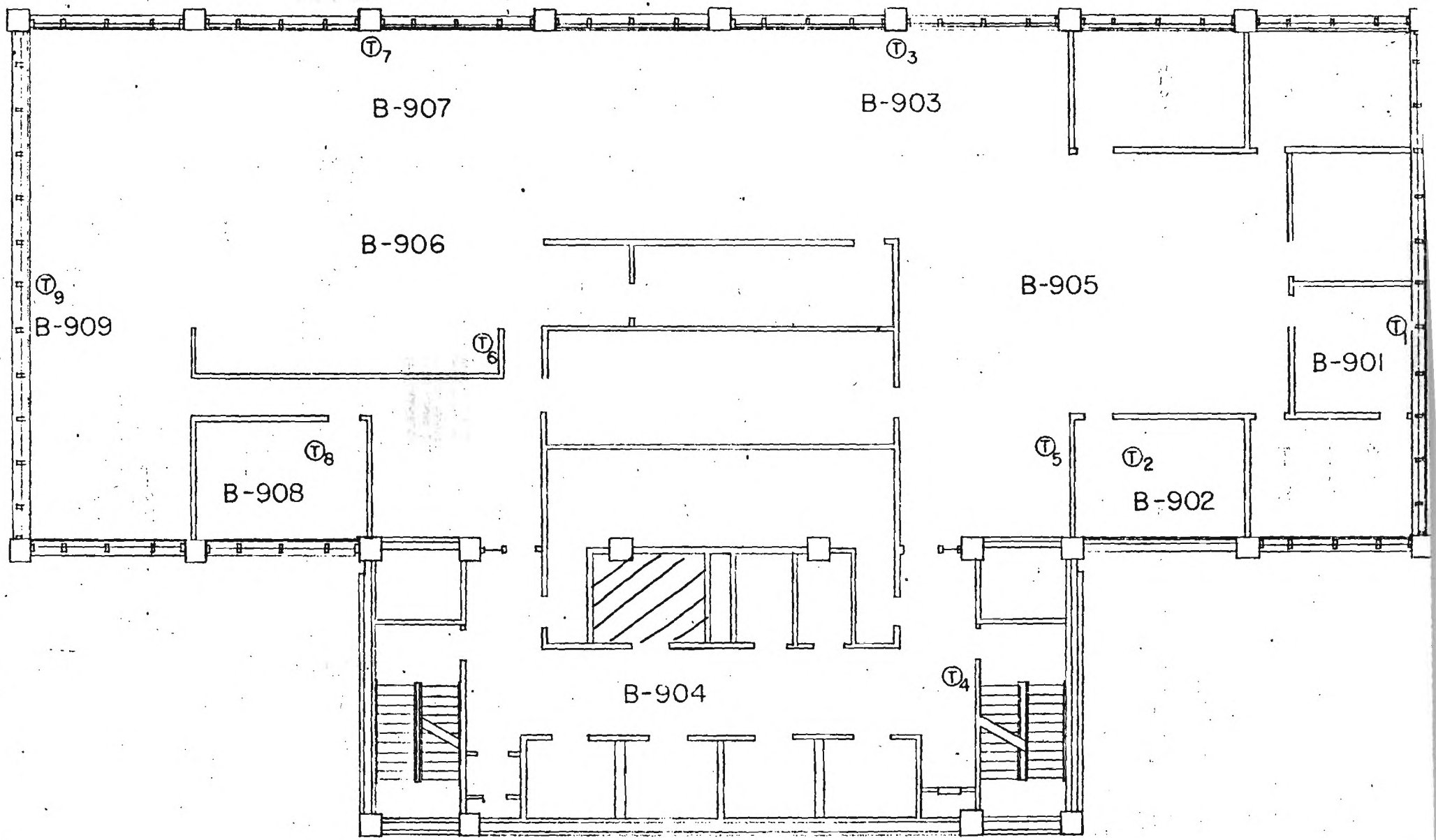
T5
T8
B-808
T2
B-802
B-804
T4


T7
T3
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B-903
B-906
T9
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B-905
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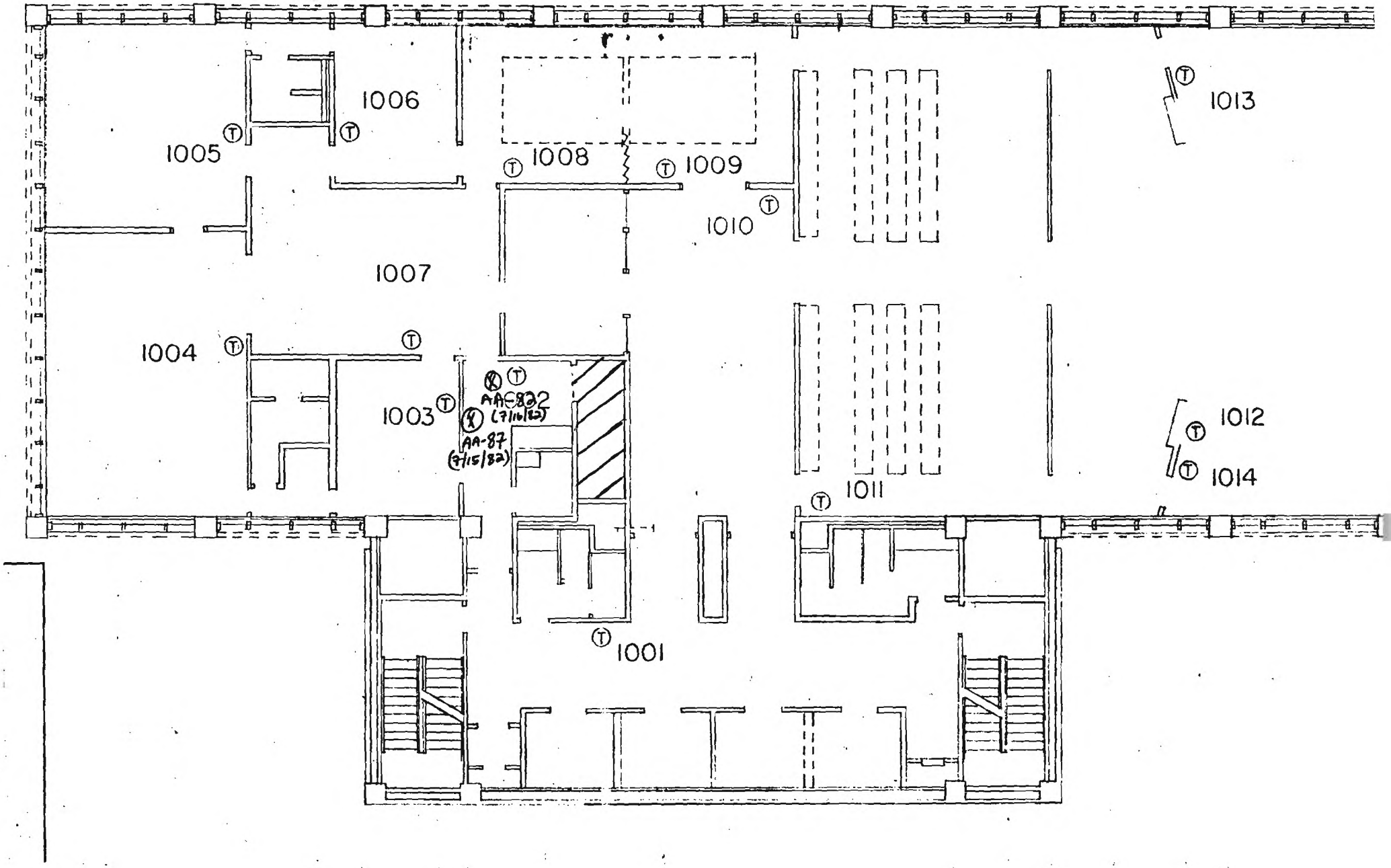
T8
B-908
T5
T2
B-902
B-904
T4


1006
1005
1008
1009
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1010
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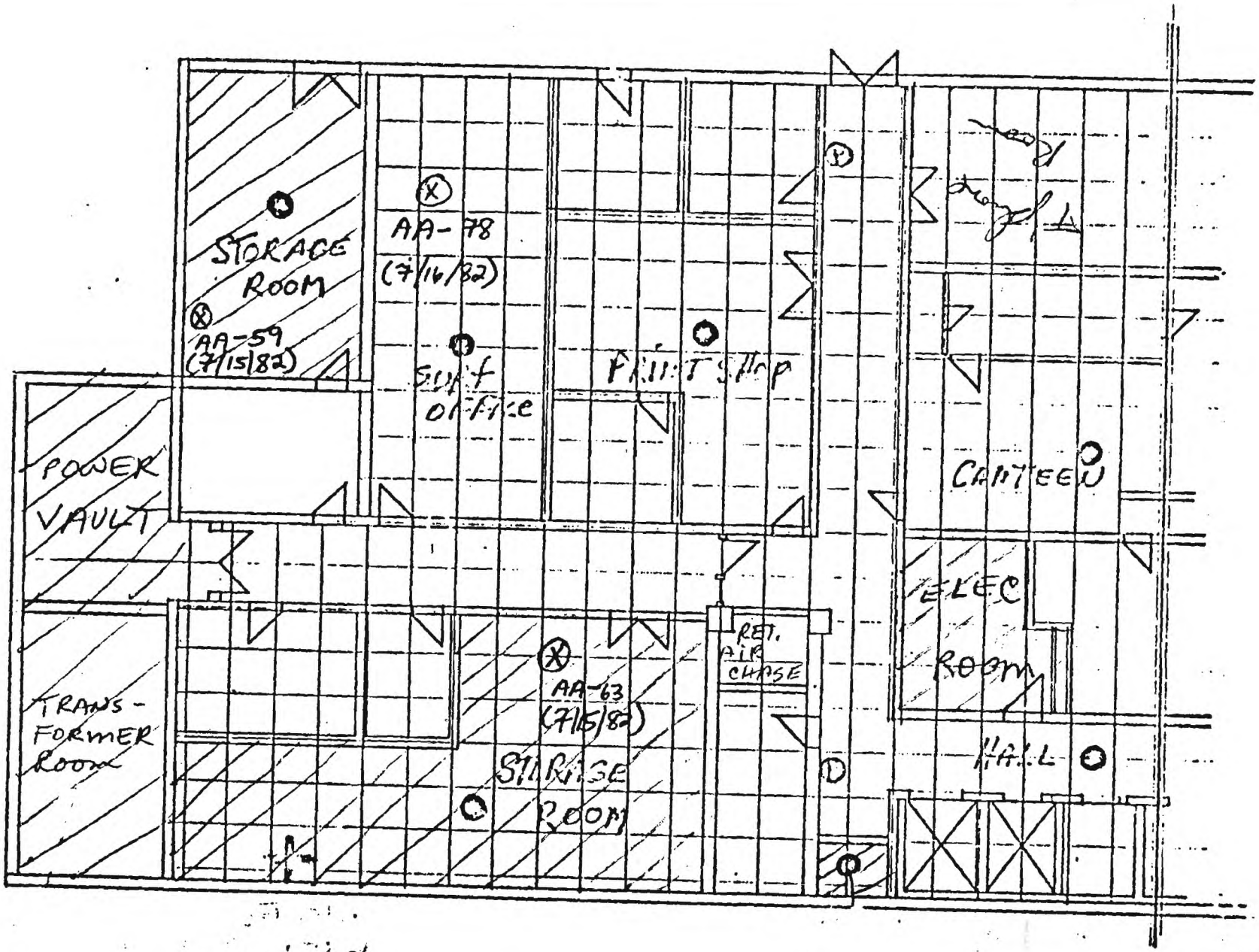
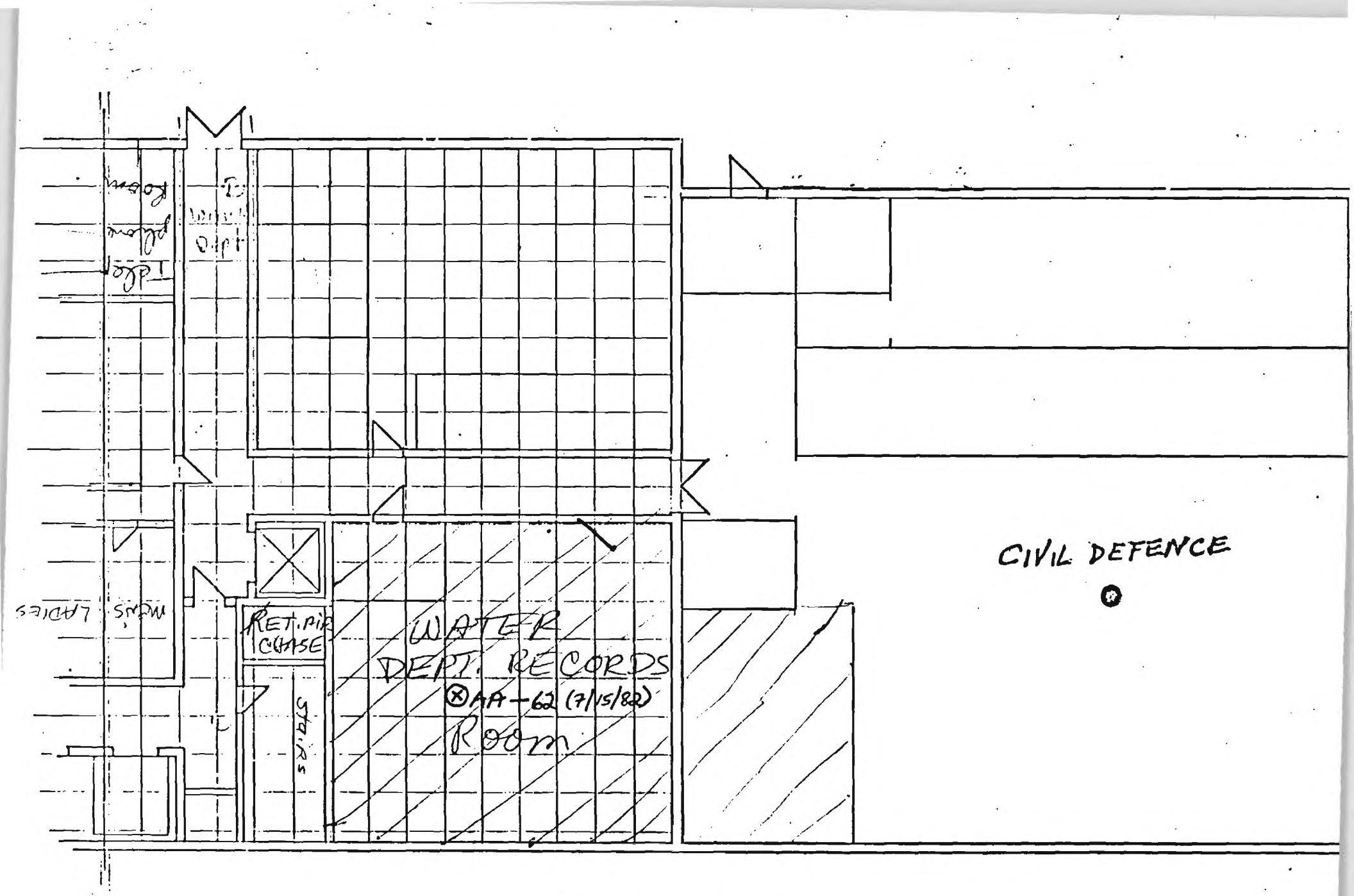
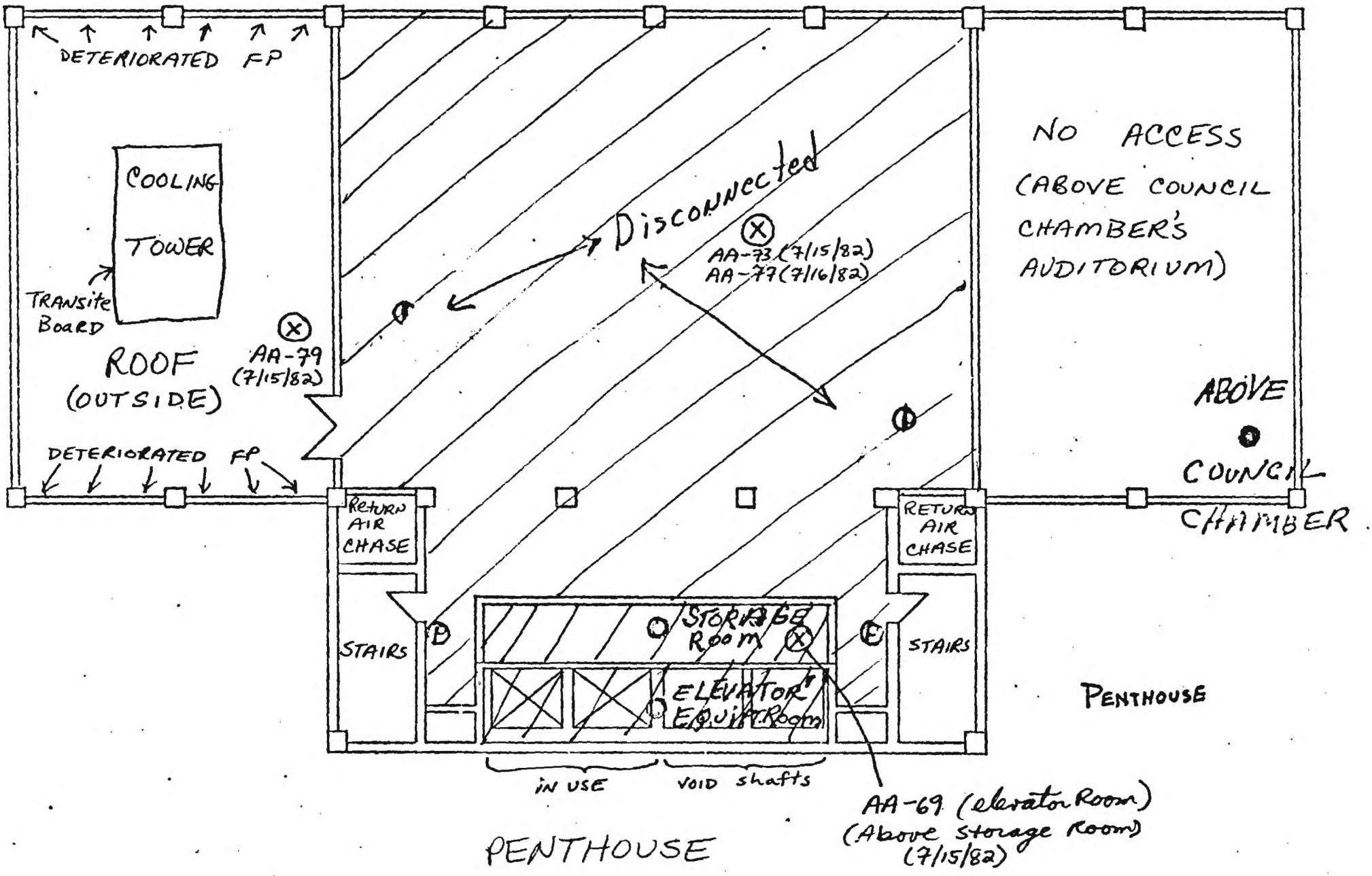
AA-82
(7/16/82)
AA-87
(7/15/82)
1012
1014
1011
1001


STORAGE ROOM
AA-59 (7/15/82)
AA-78 (7/16/82)
Supt office
FILTER ROOM
CANTEEN
POWER VAULT
ELEC ROOM
RET. AIR CHASE
AA-63 (7/15/82)
TRANS-FORMER ROOM
STAIRS ROOM
HALL

BASEMENT (A)


RET. AIR CHASE
WATER DEPT. RECORDS
⊗AA-62 (7/15/82)
Room
CIVIL DEFENCE

BASEMENT (B)


DETERIORATED FP
COOLING TOWER
TRANSITE BOARD
ROOF (OUTSIDE)
AA-79 (7/15/82)
DETERIORATED FP
DISCONNECTED
AA-73 (7/15/82)
AA-77 (7/16/82)
NO ACCESS (ABOVE COUNCIL CHAMBER'S AUDITORIUM)
ABOVE COUNCIL CHAMBER
RETURN AIR CHASE
RETURN AIR CHASE
STAIRS
STORAGE Room
ELEVATOR EQUIP. Room
STAIRS
PENTHOUSE
IN USE
VOID shafts
AA-69 (elevator Room) (Above storage Room) (7/15/82)
PENTHOUSE

APPENDIX D

NIOSH SAMPLING AND ANALYTICAL METHOD

ASBESTOS FIBERS IN AIR

National Institute for Occupational Safety and Health

Analytical Method

Analyte:	Asbestos fibers	**Method No.:**	P&CAM 239
Matrix:	Air	**Range:**	0.1-60 fibers/cm^3
Procedure:	Filter collection, microscopic count	**Precision (CV_T):**	0.24 to 0.38
Date Issued:	3/30/77	**Classification:**	D (Operational)
Date Revised:			

1. **Principle of the Method**

   1.1 This method describes the equipment and procedures for collecting, mounting, and counting asbestos fibers on cellulose ester membrane filters in the evaluation of personal samples of airborne asbestos fibers. The purpose of the method is to determine an employee's index of exposure to airborne asbestos fibers. The method is primarily a personal monitoring technique, but can be used for area monitoring.

   1.2 The sample is collected by drawing air through a membrane filter by means of a battery powered personal sampling pump. The filter is transformed from an opaque solid membrane to a transparent optically homogeneous gel. The fibers are sized and counted using a phase-contrast microscope at 400-450X magnification.

   1.3 Definitions. Asbestos fiber, for counting purposes, means a particulate which has a physical dimension longer than 5 micrometers and with a length to diameter ratio of 3 to 1 or greater. Asbestos includes chrysotile, cummingtonite-grunerite (amosite), crocidolite, fibrous tremolite, fibrous anthophyllite, and fibrous actinolite.

   1.4 Any laboratory attempting to use this procedure should have at least one counter attend a training course conducted by an experienced, proficient laboratory. Novice, untutored counters, using only published instructions, can easily obtain counts of half those performed by experienced, proficient counters. Large differences between laboratories can be caused by: 1) differences in technique and observing ability among counters and 2) small, but significant, differences between microscopes meeting the basic specifications of Section 6.2. The following procedures are recommended:

      1.4.1 All microscopists who perform asbestos counting should meet together for an "asbestos counting workshop" at least quarterly. This is best accomplished with counters from several laboratories using their own microscopes.

      1.4.2 Each microscopist should count the same series of slides and with the results being compared.

      1.4.3 Differences between counters should be resolved with side-by-side counting of the fields by the different counters.

      1.4.4 Individuals who are found to be persistent outliers over several sessions should be encouraged to seek other tasks in their respective laboratories.

2. Range and Sensitivity

2.1 The usable range is primarily a function of sample volume, microscope count field area, and background airborne particulates. The influence of these variables is discussed in 8.1.3. For a microscope count field area of 0.003 mm^2 (see Figure 1) and a pump flow rate of 1.7 lpm, the optimal fiber densities would be produced over the range of 0.4 fiber/cm^3 (8-hour sample) to about 60 fibers/cm^3 (15-minute sample). For a field area of 0.006 mm^2 (see Figure 2) and a pump flow rate of 1.7 lpm, the optimal range is 0.2 fiber/cm^3 (8-hour sample) to about 30 fibers/cm^3 (15-minute sample). In each case, the optimal detection limits are inversely proportional to pump flow rate.

The upper detection limit can be extended by using sample times less than 15 minutes or using lower flow rates. The lower detection limit can be extended by increasing the flow rate up to about 2.5 lpm. Filter surface fiber densities less than optimal (less than about 0.5 to 1.0 fiber per count field) are still adequate, but will lead to decreased precision for the method (increased coefficient of variation, see Section 4).

The minimum total fiber count in 100 fields considered adequate for reliable quantitation is 10 fibers. Thus, the lower limit of reliable quantitation is 0.1 fiber/cm^3 (100,000 fibers/m^3). For this level, a flow rate of about 2.5 lpm is recommended. For a field area of 0.003 mm^2, the minimum sample time would be about 2 hours. For a field area of 0.006 mm^2, the minimum sample time would be about 1 hour.

2.2 This method considers only fibers with a length to diameter ratio of 3 to 1 or greater and a length greater than 5 micrometers.

3. Interferences

In an atmosphere known to contain asbestos, all particulates with a length to diameter ratio of 3 to 1 or greater, and a length greater than 5 micrometers should, in the absence of other information, be considered to be asbestos fibers and counted as such.

4. Precision and Accuracy

4.1 In the past decade, there have appeared a number of articles examining sources of variation in the asbestos sampling and counting procedure. These include: Lynch et al. (11.1), Weidner and Ayer (11.2), Conway and Holland (11.3), Leidel and Busch (11.4), Beckett and Attfield (11.5), and Rajhans and Bragg (11.6). The sources of variation will be discussed by stages in the membrane filter evaluation procedure.

4.2 Sources of Variation in the Sampling Process. These include variations in pump flow rate, proximity of the filter to the employee's body, and filter location (left to right) in the employee's breathing zone.

4.2.1 Section 9.1 requires that the personal sampling pump be calibrated with sufficient accuracy such that the 95% confidence limits on the flow rate are $\pm$ 10%. This is equivalent to a coefficient of variation (CV) of about 5%. However, this CV makes a negligible contribution to the total CV for the method due to the relatively large CV of the counting procedure.

4.2.2 Conway and Holland (11.3) concluded that positioning of the filter cassette on the wearer (regarding the angular portions of the filter and their proximity to the wearer) is not a significant factor in determining the fiber distribution on filters.

4.2.3 Weidner and Ayer (11.2) concluded that there is no appreciable difference between samples collected on either the right or left sides of a breathing zone or between samples collected side-by-side, especially for samples with concentrations less than 2.5 fibers/cm^3.

4.3 Sources of Variation in the Counting Procedure

4.3.1 Random variations exist in the fiber distribution on a filter wedge (intra-wedge variability). The industrial hygiene literature has seen considerable debate in the last 20 years concerning whether or not the distribution of mineral dust or asbestos fibers on a filter surface is adequately described by a Poisson distribution probability density function. Leidel and Busch (11.4) found excellent agreement between empirical error variance and theoretical variance calculated from the assumption of Poisson distributed true counts. They concluded that there was not excessive variation among count fields for a filter wedge and that clumping of fibers (non-random coalescence) did not occur.

4.3.2 Variations exist in the fiber distribution on the total filter surface (inter-wedge variability) due to the random or non-random distribution of fibers across the total surface of the filter. This type of variation is easily confused with intra-wedge variations. The count procedure does not require counting of multiple sectors of the filter. There may be significant differences between average counts for different wedges, or the fiber distribution variations for the total filter surface may be greater than the variations of the Poisson distribution. If either of these occur experimentally, one must use the experimental variations to estimate the minimum precision of the count procedure. The minimum precision is governed by the variations of the fiber distribution on the total surface of the filter.

Conway and Holland (11.3) concluded the distribution of fibers on filters is not uniform and the distribution of fiber counts is more disperse than Poisson. For their filters which had significant variations in fiber concentrations between sectors (as much as 50-60% of the total filter mean), they described the following relation for the standard deviation of the total number of fibers counted on a wedge (N)

$$\text{empirical } s(N) = 1.6\ (N)^{1/2}$$

where N is about 100. The Poisson standard deviation would be:

$$\text{Poisson } \sigma(N) = (N)^{1/2}$$

Rajhans and Bragg (11.6) in Series I of their study found significant variation between filter segments and rejected the Poisson distribution for the total filter surface. However, in Series II of their study, utilizing various experimental modifications, they found no significant variation between filter segments and no reason to reject the assumption of Poisson distributed fiber counts.

4.3.3 Systematic variations due to differences between microscopes were studied by Leidel and Busch (11.4). In their study using five different brands of microscopes, they found no significant differences among four, but the fifth gave counts approximately 45% higher on the average than the other four.

4.3.4 Variations due to differences between counters should be examined at three levels: experienced counters occasionally counting, experienced counters routinely counting, and inexperienced (new or untutored) counters. Leidel and Busch (11.4) studied five experienced counters, with one counting only occasionally. There were no significant differences among three of the counters, but a fourth was 16% lower than the first three. The fifth, who occasionally counted, averaged 27% higher than the first three. Conway and Holland (11.3) studied three experienced counters and three inexperienced counters. They found statistically significant differences between the means of both the experienced and inexperienced counters that typically were in the range plus or minus 5 to 15%. They concluded that experience as a fiber counter is not a significant parameter affecting intercounter variations.

Rajhans and Bragg (11.6) found no significant differences among means of five experienced counters in Series I of their study. But in their carefully controlled Series II, an analysis of variance showed significant variations between counters that were plus or minus 1 to 15%.

4.3.5 Variations between laboratories are most likely due to systematic biases and are not a significant additional source of random variations. Any additional variations are most likely due to differences in counting technique. Beckett and Attfield (11.5) observed that standard counters improved greatly after personal instruction; also new counters, after instruction, tended to overcompensate and get exceedingly high counts. Additionally, they found that counts from an experienced laboratory that had not had contact with other laboratories performing the same analysis were as far from the standard values as were the counts by new counters.

4.4 Sources of variations between samples taken at different times on one employee during one work shift can affect the exposure estimate for that employee. These are primarily due to a) differences in exposure concentrations during the day, b) differences in location of the employee within the plant, and c) differences in work operation performed by the employee during the day. These sources of variation can be controlled by proper choice of sampling strategy. Refer to Leidel and Busch (11.7) and Leidel, Busch, and Lynch (11.8) for an extended discussion of sampling strategies. Interday temporal variations can affect the exposure estimates obtained on different days. Refer to Leidel, Busch, and Crouse (11.9) for a discussion of this type of variation.

4.5 Until recently, the total coefficient of variation (CV_T) for the sampling and counting procedure was best estimated from the work of Conway and Holland (11.3). The conclusions of their study included:

4.5.1 The precision of their procedure for filters not containing an abundance of fine fibers can be estimated by a coefficient of variation of 16.2%. This value includes variation among counters and observed interaction effects.

4.5.2 The accuracy of the procedure for similar filters may be estimated for a 100-fiber count by a coefficient of variation of 21.4%. This assumes that the contribution of the overall variance from the nonuniform fiber distribution is additive.

4.5.3 A high percentage of very fine fibers on the filter can significantly affect the standard deviation and confidence limits for counts by different counters. After combining variations in fiber concentrations over the entire filter with those for different counters, it was concluded:

a. For filters with a low concentration of fine fibers, the coefficient of variation is estimated at 21% and the 95% confidence interval is $\pm$ 43%.

b. For filters with a high concentration of fine fibers, the coefficient of variation is estimated at 25% and the 95% confidence interval is $\pm$ 50%.

Lynch, Kronoveter, and Leidel (11.1) have also reported on variations of the method. Their intralaboratory study utilized the data from a large number of dust counts made by different methods by experienced counters over a period of years in an epidemiologic study of the asbestos products industry. They concluded that the standard deviation of counts of fibers longer than 5 micrometers on membrane filters could be estimated from the relation $\sigma = (N)^{0.59}$. Thus for counts of about 100 fibers, the coefficient of variation could be estimated at about 15.2% and the 95% confidence limits at $\pm$ 30.4%. These values are lower than the values reported by Conway and Holland (11.3).

Recently, the Johns-Manville Corporation conducted an in-house investigation of the asbestos count method (11.10). The study data contained total fiber counts for over

100 filters with each filter counted by two to five counters. From the Johns-Manville data, NIOSH calculated over 100 estimates of the count CV for the method (11.11). The NIOSH CV estimates included random intrafilter variations and intercounter variations, but did not include random pump flow rate variations. It was found that the count coefficient of variation (all random variations except for pump variations) was a function of the total fiber count. NIOSH then included a CV of 0.05 for random pump variations (see Section 9.1) in the CV-estimator equation to obtain a CV_T-estimator. The CV_T-estimator line is plotted on Figure 3 for total fiber counts in the range 10 to 100 fibers. Or the following equation can be used:

$$CV_T = [\text{antilog}_{10}(-0.215 - 0.203\,(\log_{10}FB)) + 0.0025]^2$$

where FB is total fiber count as discussed in Section 10.

Figure 3 demonstrates that for a total fiber count of 100, the best CV_T is attainable with the appropriate sampling times given in 8.1.3 and the count rules in 8.3.9. When making decisions regarding compliance with the OSHA asbestos exposure standards in 29 CFR 1910.1001, the statistical procedures given in Leidel et al. (11.11) should be followed. The procedures are based on statistical theory and assumptions given in References 11.12, 11.13.

Because of the possibility of systematic biases due to differences between microscopes, counters, and laboratories as discussed above, it is strongly recommended that any laboratory counting asbestos should participate in an interlaboratory quality control program that includes the counting of standard reference filters. These standard filters are available from NIOSH through the Proficiency Analytical Testing (PAT) Program. The PAT Program is used by the American Industrial Hygiene Association (AIHA) as part of its Laboratory Accreditation Program. Each laboratory's quality control program must include protocols for routinely adjusting and calibrating sampling and counting equipment plus training and evaluation programs for counters.

5. Advantages and Disadvantages of the Method

5.1 The method is intended to give an index of employee exposure to airborne asbestos fibers of specified dimensional characteristics.

5.2 It is not meant to count all asbestos fibers in all size ranges or to differentiate asbestos from other fibrous particulates.

6. Apparatus

6.1 Sampling Equipment

The personal sampling equipment train consists of 1) personal sampling pump, 2) tubing, 3) clothing spring clip, 4) tubing-to-field monitor metal adaptor, and 5) field monitor (filter and holder).

6.1.1 Personal Sampling Pump. The pump must be capable of sampling at 1.0 to 2.5 liters per minute (lpm) against a flow resistance of 7.5 inches of water (1.4 cm Hg) for 8 continuous hours on a fully charged battery.

6.1.2 Tubing. Laboratory tubing such as rubber or plastic with 6-mm bore and about 100 cm length.

6.1.3 Clothing Spring Clip. The clip attaches the rubber tubing to the lapel or shirt of the individual being monitored.

6.1.4 Tubing-to-field Monitor Adaptor. A short metal adaptor with ridges on one end to grip the inside of the tubing. The other end is designed for a pressure fit into the field monitor.

6.1.5 Field Monitor (Filter and Holder). The only field monitor currently considered acceptable by NIOSH is manufactured by the Millipore Corporation. The unit con-

sists of 1) a three section styrene plastic case designated Millipore Aerosol Monitor Case, 2) a 37-mm diameter plain white cellulose ester membrane filter designated Millipore AA (pore size of 0.8 micrometer), 3) a support pad, and 4) two plastic sealing caps. If a large number of samples are to be taken, it may be less expensive to reuse the plastic cases. Great care must be taken in the cleaning and reassembly process. The outside mating surfaces of the field monitors may be covered with a "shrink-fit" band to provide proper sealing and a writing surface for filter identification.

6.2 Optical Equipment and Microscope Features

6.2.1 Microscope body with binocular head.

6.2.2 10X Huygenian eyepieces are recommended. Other eyepieces can be substituted if necessary. Wide field eyepieces can be used; however, wide field eyepieces may yield a count field area less than 0.003 mm^2 with the Porton reticle. This is not always desirable from the standpoint of obtaining optimum sampling times (see Section 8.1.3). If wide field eyepieces are used, it is preferable to use the Patterson Globe and Circle reticle to obtain a larger count field area.

6.2.3 Koehler illumination (preferably built-in with provisions for adjusting light intensity).

6.2.4 A Porton reticle is recommended. Others such as the Patterson Globe and Circle can be substituted.

6.2.5 Mechanical stage.

6.2.6 Phase-Contrast condenser with a numerical aperture (N.A.) equal to or greater than the N.A. of the objective.

6.2.7 40-45X phase contrast achromatic objective (N.A. 0.65 to 0.75).

6.2.8 Phase-ring centering telescope or Bertrand lens.

6.2.9 Green or blue filter, if recommended by microscope manufacturer.

6.2.10 Stage micrometer with 0.01 mm subdivisions.

6.2.11 For general guidance on phase contrast microscopy, consult Needham (11.12), Clark (11.15) and McCrone (11.14).

6.3 Filter Mounting Equipment. Experience has shown that certain equipment is useful for efficient sample mounting. The following items are recommended for extracting and mounting a portion of the filter for counting.

6.3.1 Microscope slides. 2.5 by 7.5 cm glass slides are most commonly used. Sample number, data, initials, etc., can be conveniently written on a frosted end slide.

6.3.2 Cover Slips. Cover slips are a necessary part of the slide mount and optical system. The shape should be appropriate for the size of the filter wedge. The appropriate cover slip depends upon the objective to be used. Ordinarily, objectives are optically corrected for a #1½ (0.17 millimeter) thickness cover slip. Improper cover glass thickness will detract from the final image quality.

6.3.3 Scalpel. A scalpel is needed to cut out a portion of the filter to be examined. A number-ten curved blade scalpel is recommended.

6.3.4 Tweezers. A pair of fine-tipped tweezers is used to remove the membrane filter slice from the field monitor and place it upon the slide.

6.3.5 Lens Tissue. To insure cleanliness, a lint-free tissue is recommended. This tissue should also be used for wiping mounting tools and for cleaning slides and cover slips.

6.3.6 Glass Rod. A fire-polished glass rod may be used to spread the mounting solution on the slide.

6.3.7 Wheaton Balsam Bottle. This special glass container has a glass top which prevents contamination of the mounting solution. A glass rod is included for dispensing the solution.

7. Reagents

Chemicals should be reagent grade, free from particles and color, conforming to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available.

7.1 Dimethyl phthalate

7.2 Diethyl oxalate

Avoid getting the mounting solution on the skin. Wash skin promptly with soap and water if skin contact occurs.

8. Procedure

8.1 Sampling

8.1.1 General Information

Guidelines for the monitoring of employee exposures to industrial atmospheres are given in Reference 11.8. The Federal requirements for monitoring employee exposure to airborne asbestos are found in 29 CFR 1910.1001.

8.1.2 Mounting the Sampling Pump on the Worker

Fasten the sampling pump to the worker's belt and fasten the field monitor to the lapel or shirt front (as close to the breathing zone as is practical). Remove the top cover of the plastic monitor, then invert the monitor making certain the exposed filter is facing downward. Turn the pump on and adjust to the calibrated flow rate (1.0 to 2.5 lpm). Record the following information in a logbook.

1. Filter number
2. Pump start time and date
3. Flow rate
4. Subject's name and job title
5. Type of operation or process
6. Ventilation controls and is the worker wearing a respirator approved for asbestos?

The pump should be checked periodically during the sampling period for proper operation and flow rate.

8.1.3 Optimum Sampling Times

The requirement for the minimum count of 100 fibers or 20 fields in 8.3.9 was determined to be the best compromise to achieve adequate precision for the airborne fiber estimate and reasonable counting times. An optimum fiber density of about 1 to 5 fibers per microscope count field is recommended. To estimate appropriate sampling times for feasible counting and optimal counting, one must consider the following constraints:

1. microscope count field area (generally 0.003 to 0.006 mm^2)
2. pump flow rate (typically 2.5 lpm maximum)
3. average airborne fiber concentrations
4. counting rule range of 20 to 100 fields
5. adequate fiber density to obtain a minimum count of 10 fibers in 100 fields, which is the least total fiber count that yields an acceptable count precision
6. background airborne particulate levels that can reduce the count precision due to an obscuring of fibers on the filter surface

The preceding constraints were considered in drawing Figures 1 and 2. These figures were developed from the following relationship:

$$\text{sampling time} = \frac{(FB/FL)\,(ECA/MFA)}{(FR)\,(AC)\,(1000)} \quad \text{minutes}$$

where:

FB/FL = 1 to 5 fibers/field

ECA = effective collecting area of filters (855 mm^2 for 37-mm filter with effective diameter of 33 mm)

MFA = microscope field area (generally 0.003 to 0.006 mm^2)

FR = Pump flow rate (generally 1.0 to 2.5 lpm)

AC = Air concentration of fibers in fibers/cm^3.

Figure 1 (microscope field area = 0.003 mm^2) and Figure 2 (microscope field area = 0.006 mm^2) show optimum and feasible sampling times for a pump flow rate of 1.7 lpm. Each individual responsible for sampling asbestos should prepare a similar chart for his particular pump flow rate and microscope field area before sampling is performed to aid in estimating proper sampling times. On Figures 1 and 2, the areas with solid shading lines are generally the optimum conditions for counting. The broken shading lines are for conditions very close to optimal.

However, feasible counting conditions may extend down to about 0.1 fiber/field and and above 5 fibers/field. Recommended sampling times are most strongly influenced by background airborne particulate levels, once all the other constraints have been estimated. For heavy particulate levels, it may be necessary to limit each filter to about 60 to 180 minutes sampling duration. Each individual responsible for sampling should work closely with the microscopist to attain as high as possible filter surface fiber densities (up to about 5 fibers/field), while avoiding filter surface background particulate levels that create very difficult or impossible counting conditions. If one has very little idea of airborne fiber and particulate levels, the best procedure is to take several long samples (as one 8-hour or two consecutive 4-hour samples) in conjunction with several short samples (as four consecutive 2-hour or eight consecutive 1-hour samples). If the longer samples prove very difficult to count, the microscopist will have the shorter samples to fall back on.

From Figures 1 and 2, it can be seen that there are certain sampling times which will yield optimum fiber densities on the filter for almost all airborne fiber concentrations from 1 to 10 fibers/cm^3. These optimum times have been calculated and are presented in Figure 4. Note that the optimum times given by Figure 4 are approximate and can be varied by as much as ± 25%. The nomogram is intended as a guide to be used where no prior knowledge of the air concentration is available.

8.1.4 End of Sampling Period

Remove the field monitor, replace the plastic top cover and the small end caps, and store the monitor. Always shut off the pump when changing monitors to avoid contaminating or damaging the pump. Record the pump shutoff time and flow rate in the logbook.

8.1.5 Blanks

With each batch (25 to 50 filters) of samples sent for analysis, submit two unopened field monitors which have been subjected to the same treatment as the samples except that they were not exposed to the sampling environment. Label these as blanks. If the blanks yield fiber counts greater than 5 fibers/100 fields, then the entire sampling procedure should be examined carefully for the cause of contamination. The

mounting solution of Section 8.2.1 should also be examined for contamination and/or crystal growth.

8.1.6 Shipping

The field monitors in which the samples are collected should be shipped in a rigid container with sufficient packing material to prevent crushing.

8.1.7 Numbers of Samples

When sampling for the Federal ceiling standard of 10 fibers (>5μm)/cm³, [29 CFR 1910.1001(b) (3), effective July 7, 1972], only one sample (15 minutes maximum duration) is necessary, theoretically. However, several samples should be taken during expected periods of peak air concentrations to allow for detection of gross sampling or counting errors.

When sampling for determination of noncompliance with the Federal 8-hour TWA standard of 2 fibers (>5μm)/cm³, [29 CFR 1910.1001(b) (2)], one should continuously sample as large a portion of the work day as is feasible for airborne concentrations of about 2 to 10 fibers/cm³. However, for a lower airborne concentration such as 0.5 fiber/cm³, one sample might require 4 to 8 hours sampling time in order to get the proper filter fiber density (Section 8.1.3). For this situation, the 8-hour TWA exposure would be determined from one 8-hour or two 4-hour samples as appropriate.

8.2 Sample Preparation

8.2.1 Preparation of Mounting Solution

A very important part of the sample evaluation is the mounting process. This process involves a special mounting medium of prescribed viscosity. The proper viscosity is important in order to expedite filter dissolving and still minimize particle migration. After the sample has been mounted, an elapsed time of approximately sixty minutes is needed before the sample is ready for evaluation.

Combine the dimethyl phthalate and diethyl oxalate in a one to one ratio by volume and pour into a Wheaton balsam bottle. Add approximately 0.05 (≐ 0.005) grams of new membrane filter per milliliter of solution to reach the necessary viscosity. The mixture must be stirred periodically until the filters have dissolved and a homogeneous mixture is formed. The normal shelf life of the mounting solution is about three months. Twenty milliliters of mounting solution will prepare approximately 300 samples.

8.2.2 Sample Mounting

Cleanliness is important! A dirty working area may result in sample contamination and erroneous counts. The following steps should be followed when mounting a sample.

1. Clean the slides and cover slips with lens tissue. Lay each slide down on a clean surface with the frosted end up. It is a good practice to rest one edge of the cover slip on the slide and the other edge on the working surface. By doing this, you keep the bottom surface (the one which contacts the filter) from becoming contaminated.
2. Wipe all the mounting tools clean with lens tissue and place them on a clean surface (such as lens tissue). All tools should be wiped clean prior to mounting each sample.
3. Using the glass rod supplied with the Wheaton balsam bottle, apply a drop of mounting solution onto the center of the slide. It may be necessary to adjust the quantity of solution so that after the cover slip has been placed on top, the solution extends only slightly beyond the filter boundary. If the quantity is greater than this, particle migration may occur.

4. Using another glass rod, spread the mounting media into a triangular shape. The size of this triangle should coincide with the dimension of the filter wedge.
5. Separate the middle and bottom sections of the field monitor case to expose the filter. Cut a triangular wedge from the center to the edge of the filter using the scalpel. The size of the wedge should approximate one-eighth of the filter surface. The filter can be very carefully removed from the cassette for cutting, but this should only be done with great care.
6. Grasp the filter wedge with the tweezers on the perimeter of the filter which was clamped between the monitor case sections. Do not touch the filter with your fingers. Place the wedge, sample side up, upon the mounting medium.
7. Pick up a clean cover slip with tweezers and carefully place it on the filter wedge. Once this contact has been made, do not reposition the cover slip.
8. Label the slide with the sample number and current date before proceeding to the next filter. On the bottom (backside) of the slide, trace the perimeter of the filter wedge with a felt tip marking pen. This will enable the counter, after the filter has become transparent, to stay within the filter perimeter when counting.
9. The sample should become transparent within fifteen minutes. If the filter appears cloudy, it may be necessary to press very lightly on the cover slip. This is rarely necessary; however, counting should not be started until an hour after the mounting. This allows the microscopic texture of the filter to become invisible to microscope viewing.
10. Discard the sample mount after two days if it has not been counted. Crystals appearing similar to asbestos fibers may begin to grow at the mounting media/air interfaces. They seldom present any problems if the slide is examined before two days. In any case, stay away from the filter's edges when counting and sizing.

8.3 Counting of Fibers

8.3.1 Place the slide on the mechanical stage of the microscope and position the center of the wedge under the objective lens and focus upon the sample. Start counting from one end of the wedge and progress along a radial line to the other end (count in either direction from perimeter to wedge tip). Random fields are selected, without looking into the eyepieces, by slightly advancing the slide in one direction with the mechanical stage control.

8.3.2 It is essential to continually scan over a range of focal planes (generally the upper 10 to 15 micrometers of the filter surface) with the fine focus control during each field count. This is especially necessary for asbestos fibers due to their impaction into the filter matrix.

8.3.3 On most airborne samples, asbestos fibers will generally have fiber diameters less than one micrometer. Therefore, it is necessary to look carefully for faint fiber images.

8.3.4 Regularly check phase ring alignment.

8.3.5 When an agglomerate (mass of material) covers a significant portion of the field of view (approx 1/6 or greater) reject the field and select another. (Do not include it in the number of fields counted.) However, report the fact as it may have meaning on other data collection.

8.3.6 Bundles of fibers are counted as one fiber unless both ends of the fiber can be clearly resolved.

8.3.7 Count only fibers with a length to width ratio greater than or equal to 3:1.

8.3.8 Count only fibers greater than 5 micrometers in length. (Be as accurate as possible in accepting fibers near this length.) Measure curved fibers along the curve to estimate the total length.

8.3.9 Count as many fields as necessary to yield a total count of at least 100 fibers. Exceptions: a) count at least 20 fields even if you count more than 100 fibers, and b) stop at 100 fields even if you haven't reached 100 fibers.

8.3.10 For fibers that cross either one or two sides of the counting field, the following procedure is used to obtain a representative count.

COUNT any fiber greater than 5 micrometers in length, that lies entirely within the counting area. COUNT as "½ fiber" any fiber with only one end lying within the counting area. DO NOT COUNT any fiber crossing any two sides.

Reject and do not count all other fibers. Refer to Figures 5 through 10. Note that the fibers in Figures 5 through 10 are not representative of the appearance of most asbestos fibers. Most fibers have a very faint image.

9. Calibration and Standards

9.1 Sampling Train Calibration

The accurate calibration of the sampling pump is essential to the correct calculation of the air volume sampled. The frequency of calibration is dependent on the use, care, and handling to which the pump is subjected. Pumps must be recalibrated if they have just been repaired, misused, or received from the manufacturer. If the pump receives hard usage, more frequent calibration may be necessary. Ordinarily, pumps should be calibrated in the laboratory both before they are used in the field and after they have been used to collect a large number of field samples.

The accuracy of calibration is dependent upon the type of instrument used as a reference. The choice of a calibration instrument will depend largely on where the calibration is performed. For laboratory testing, a 1-liter buret used as a soap bubble flow meter or wet-test meter is recommended. Other standard calibrating instruments, such as a spirometer, Mariott's bottle, or dry gas meter can be used. The calibration should be of sufficient precision that the 95% confidence limits on the flow rate are ± 10% (95% of the flow rates will fall within ± 10% of the calibrated value).

Instructions for calibration with the soap bubble flow meter follow. The sampling train used (pump, hose, filter cassette) in the pump calibration should be the same as the one used in the field.

9.1.1 Check the voltage of the pump battery with a voltmeter both with the pump off and while it is operating to assure adequate voltage for calibration. If necessary, charge the battery to manufacturer's specifications.

9.1.2 Fill a beaker with 10 ml of soap solution.

9.1.3 Connect the filter cassette inlet to the top of the buret with a length of hose.

9.1.4 Turn the pump on and moisten the inside of the soap bubble meter by immersing the open end of the buret into the soap solution and drawing bubbles up the inside of the buret. Perform this task until the bubbles are able to travel the entire length of the buret without breaking.

9.1.5 Adjust the pump rotameter to provide a flow between 1.5 to 2.5 lpm.

9.1.6 With a water manometer, check that the pressure drop across the filter is less than 13 inches of water (about 1 inch of mercury).

9.1.7 Start a soap bubble up the buret and measure the time it takes for the bubble to travel a minimum volume of 1 liter.

9.1.8 Repeat the procedure in 9.1.7 at least three times, average the results, and calculate the calibrated flow rate by dividing the volume traveled by the soap bubble by the elapsed time. If the range between the highest and lowest of the three flow rates is greater than about 0.33 lpm, then the calibration should be repeated since it is likely that the precision is not adequate.

9.1.9 Data required for the calibration include the volume measured, elapsed time, pressure drop, air temperature, atmospheric pressure (or elevation), pump serial number, date, and name of person performing the calibration.

9.1.10 Corrections to the flow rate for pumps with rotameters may be necessary if the pressure (elevation) or temperature where the samples are collected (actual flow rate) differs significantly from that where the calibration was performed (indicated flow rate). Actual flow rates at time of sampling may be calculated for a linear scale rotameter by using the following correction formula:

$$Q_{actual} = Q_{indicated} \sqrt{\frac{P_{cal}}{P_{actual}} \cdot \frac{T_{actual}}{T_{cal}}}$$

where both pressure (P) and temperature (T) are in absolute units such as:

psia = psig + 14.7
deg Rankin = deg Fahrenheit + 460
deg Kelvin = deg Celsius + 273

9.2 Microscope Setup

9.2.1 Porton Reticle and the Counting Field

The asbestos fiber count procedure consists of comparing fiber length to the diameters of calibrated circles of a Porton reticle, and counting all fibers greater than 5 micrometers in length lying within a given counting field area. The Porton reticle is a glass plate inscribed with a series of circles and rectangles. The left half of the reticle is divided into six rectangles constituting the counting field. The counting field is illustrated in Figures 5 through 10.

9.2.2 Placement in Eyepiece

The Porton reticle is placed inside the Huygenian eyepiece where it rests on the field-limiting diaphragm. If other types of eyepieces are used, it may be necessary to insert a counting collar for retaining the reticle. The reticle should always be kept clean, since dirt on the reticle is in focus and could complicate the counting and sizing process.

9.2.3 Stage Micrometer

The Porton reticle cannot be used for counting until it has been properly calibrated with a stage micrometer. Most stage micrometer scales are approximately two millimeters long and are divided into units of one-hundredth of a millimeter (ten micrometers).

9.2.4 Microscope Adjustment

When adjusting the microscope, follow the manufacturer's instructions while observing the following guidelines.

1. The light source image must be in focus and centered on the condenser iris or annular diaphragm.
2. The particulate material to be examined must be in focus.
3. The illuminator field iris must be in focus, centered on the sample, and opened only to the point where the field of view is illuminated.
4. The phase rings (annular diaphragm and phase-shifting elements) must be concentric.

9.2.5 Porton Reticle Calibration Procedure

Each eyepiece-objective-reticle combination on the microscope must be calibrated. Should any of the three be changed (disassembly, replacement, zoom adjustment, etc.), the combination must be recalibrated. Calibration may change if interpupillary dis-

tance is changed. For proper calibration, the following procedure should be followed closely.

With a 10X objective in place, place the stage micrometer on the mechanical stage, focus the millimeter scale, and center the image. Change to the 40-45X objective and adjust the first millimeter scale division to coincide with the left boundary of the Porton rectangle. Measure the distance between the left and extreme right boundaries of the Porton rectangle, estimating any portion of the final division. This measurement represents 200 L units. The rectangle is 100 L units on the short vertical dimension. The calculated "L" is inserted into the formula $D = L(2^N)^{1/2}$ where "N" is the circle number (indicated on the reticle) and "D" is the circle diameter. Since the circle diameters vary logarithmically, every other circle doubles in diameter. For example, circle number three is twice the diameter of number one; number four is twice the diameter of number two. When the circle sizes have been determined, the counting field area which consists of the left six smaller rectangles can be calculated from the relation 10,000 L^2. This completes the reticle calibration for this specific objective-eyepiece-reticle combination.

Example for Porton Reticle

The following calibration was obtained for a pair of 10X Huygenian eyepieces and a 43X objective:

200 L = 0.148 mm = 148 micrometers

100 L = 0.074 mm = 74 micrometers

One L-unit = 0.74 micrometers

Thus Circle #1 has a diameter $D = L(2^N)^{1/2} = 0.74(2^1)^{1/2} = 0.74 \quad (1.414) = 1.05$ micrometers.

Then our circle diameter calibration table looks like:

Diameter of Circle #1 = 1.05 micrometers
#2 = 1.48
#3 = 2.09
#4 = 2.96
#5 = 4.19
#6 = 5.92

Field area = (10,000) (L^2) = (100 L) (100 L) = (0.074) (0.074) = 0.0055 mm^2

Thus fibers with a length greater than a distance halfway between the diameters of the #5 and #6 circles would be counted.

If a Patterson Globe and Circle reticle is used, a different calculation procedure is required. The circle diameters are related as follows. The #25 circle diameter is (0.1) (reticle length).

The circle diameters are proportional to the ratio of their numbers. Thus the #20 circle diameter is (20/25) or 0.8 times the #25 circle diameter.

10. Calculations

10.1 The average airborne asbestos fiber concentration estimated by the filter sample may be calculated from the following formula:

$$AC = \frac{[(FB/FL) - (BFB/BFL)]\ (ECA)}{(1000)\ (FR)\ (T)\ (MFA)}$$

where:

AC = Airborne fiber concentration in (fibers > 5 μm)/cm^3.
BFB = Total number of fibers counted in the BFL fields of the blank or control filters in fibers > 5 μm.
BFL = Total number of fields counted on the blank or control filters.
ECA = Effective collecting area of filter (855 mm^2 for a 37-mm filter with effective diameter of 33 mm).
FR = Pump flow rate in liters/min (lpm).
FB = Total number of fibers counted in the FL fields in fibers > 5 μm.
FL = Total number of fields counted on the filter.
MFA = Microscope count field area in mm^2 (generally 0.003 to 0.006).
T = Sample collection time in minutes.

10.2 Recount criteria. It is very desirable for a counter to conduct a "blind recount" for about 1 in every 10 filter wedges (slides) counted. Alternatively, a second counter could perform the blind recount. In training sessions for novice counters, the trainee should conduct a blind recount for filter wedges counted by an experienced, proficient counter. In all cases, we will observe differences between the first and second counts of the same filter wedge. Most of these differences will be due to chance alone, that is, due to the random variability (precision) of the count method. Statistical recount criteria enable us to decide whether observed differences can reasonably be explained due to chance alone or are probably due to systematic differences between counters or microscopes or due to some other biasing factor.
The following recount criterion is for a pair of counts that estimate some airborne fiber concentration (AC) in fibers/cm^3. The criterion is given at the type-I error level. That is, there is a 5% maximum risk that we will reject a pair of counts for the reason that one might be biased, when the large observed difference is really due to chance.
Reject a pair of counts because one might be biased if:

$$(AC_2 - AC_1) \text{ exceeds } 2.77(\overline{AC})(CV_{FB})$$

where:

AC_1 = lower estimated airborne fiber concentration
AC_2 = higher estimated airborne fiber concentration
$\overline{AC}$ = average of the two airborne concentration estimates
CV_{FB} = average CV for the two concentration estimates which are a function of the total fiber count (FB) in each case. Use the relation in Section 4 or Figure 3.

For a pair of counts on the same filter, reject the pair because one might be biased if:

$$(FB_2 - FB_1) \text{ exceeds } 2.77(\overline{FB})(CV_{\overline{FB}})$$

where:

FB_1 = lower fiber count on the filter (total fibers)
FB_2 = higher fiber count on the filter (total fibers)
$\overline{FB}$ = average of the two total fiber counts
$CV_{\overline{FB}}$ = CV_T for the value FB. Use the relation in Section 4 or Figure 3.

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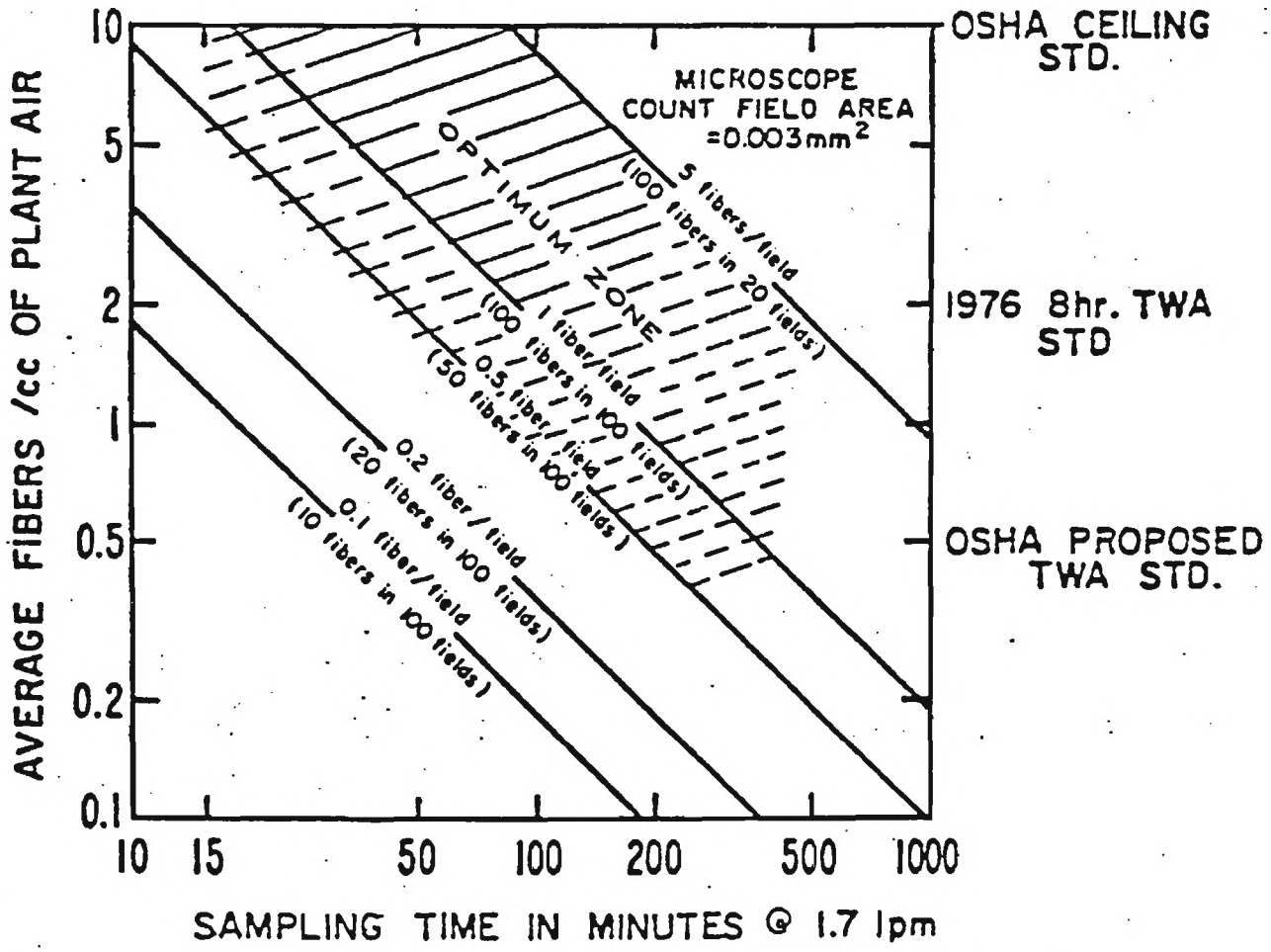

FIGURE 1. Optimum Sampling Times for airborne asbestos where microscopic field area = 0.003 mm²

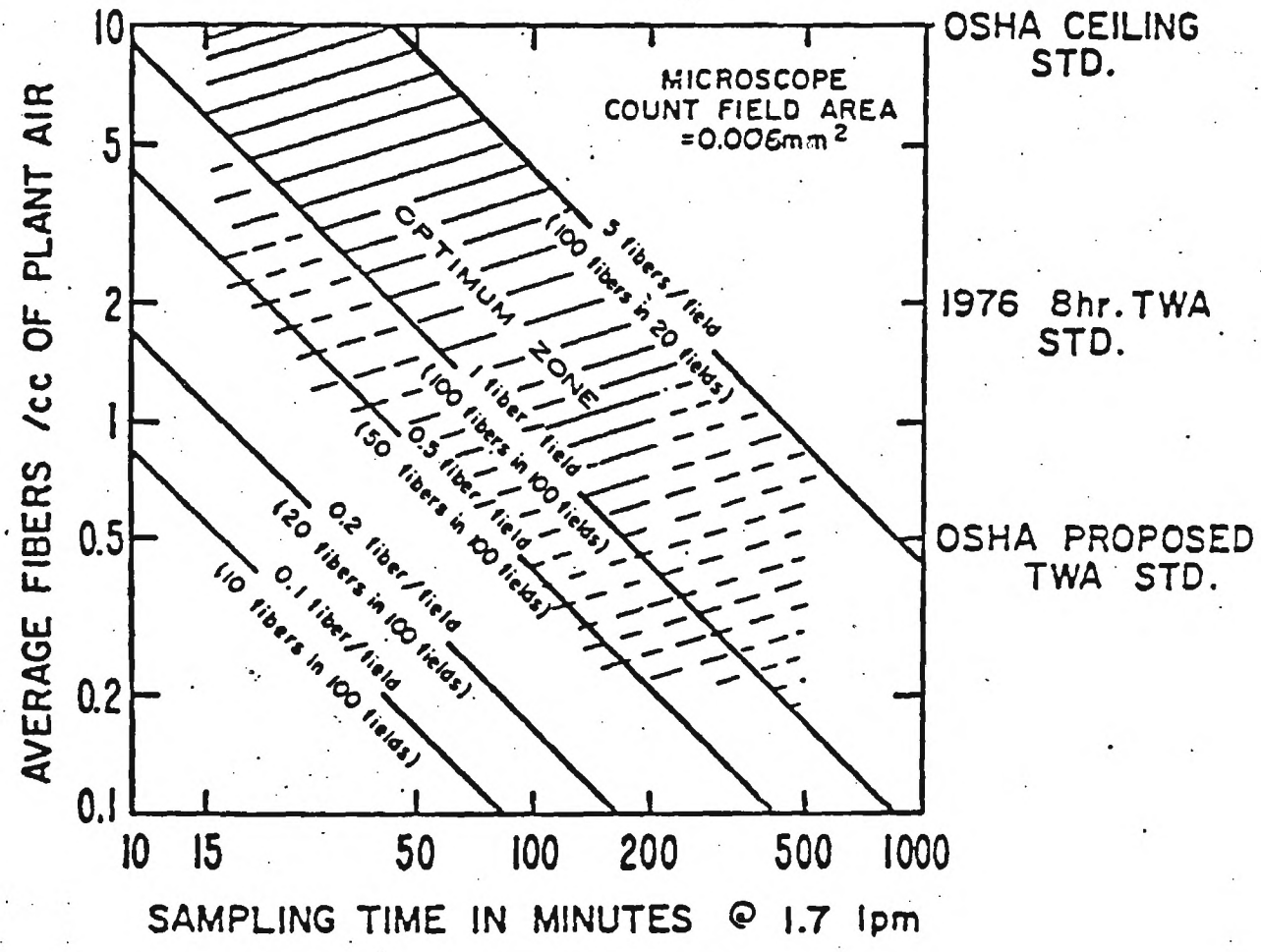

FIGURE 2. Optimum sampling times for airborne asbestos where microscopic field area = 0.006 mm²

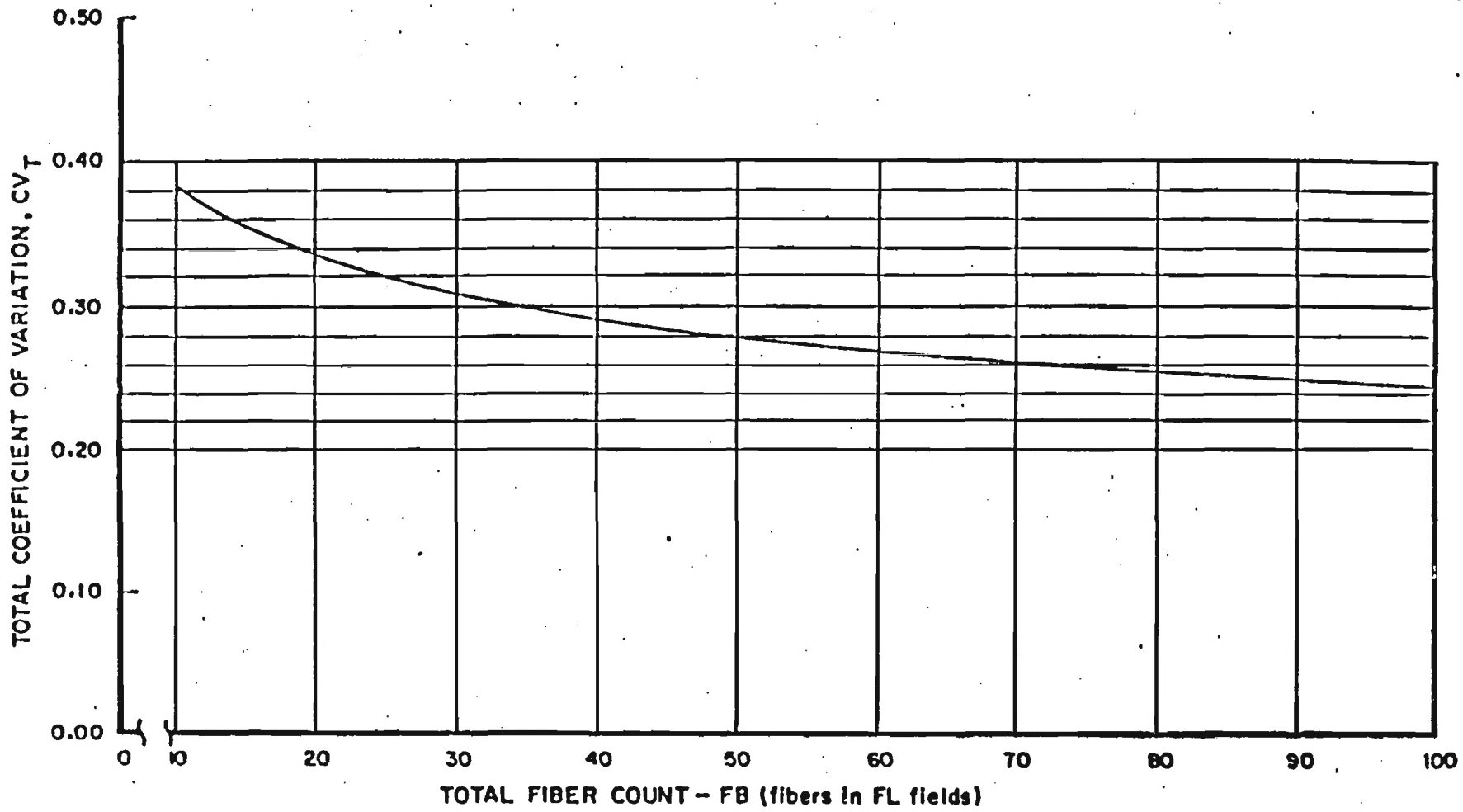

FIGURE 3. Total coefficient of variation as a function of total fiber count

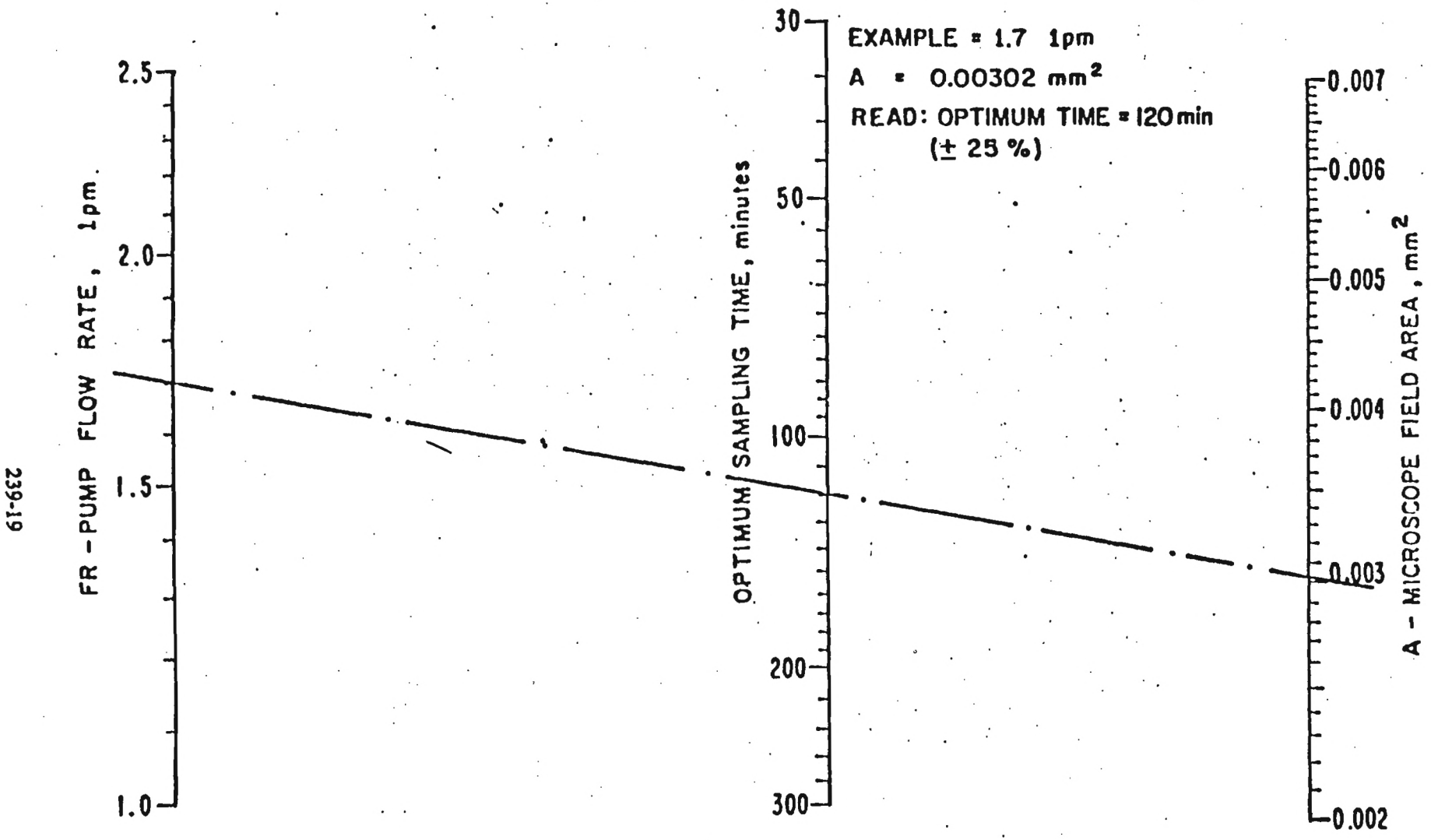

FIGURE 4. Nomogram of optimum sampling times for airborne asbestos fibers in concentrations of 1 to 10 fibers/cm³

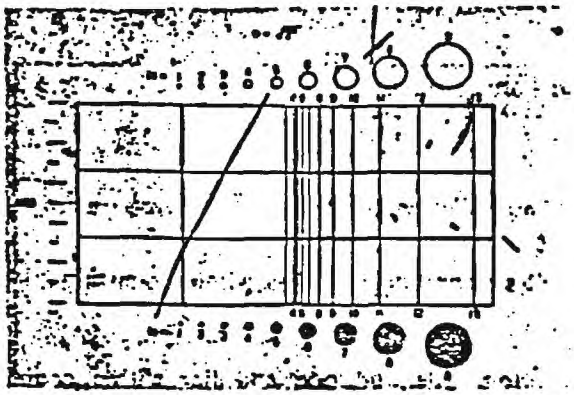

FIGURE 5

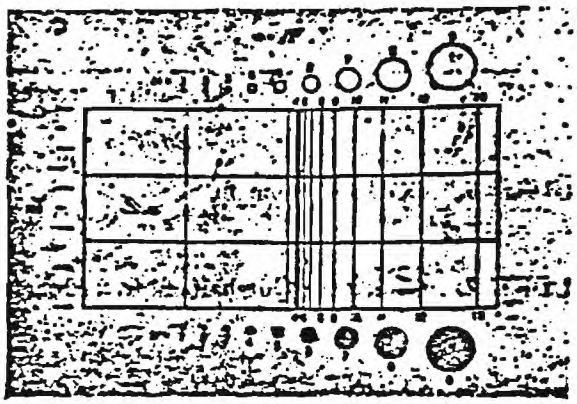

FIGURE 6

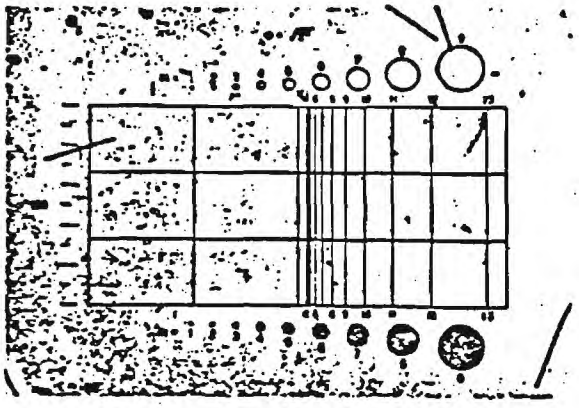

FIGURE 7

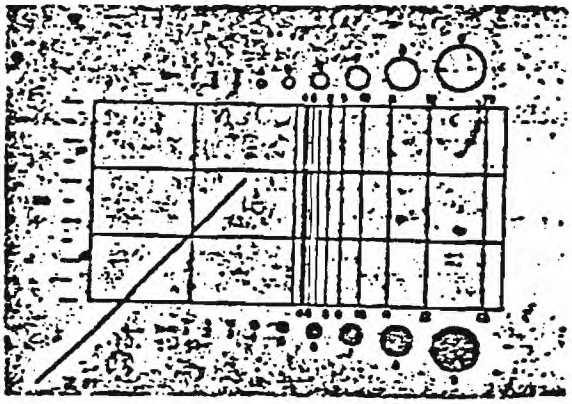

FIGURE 8

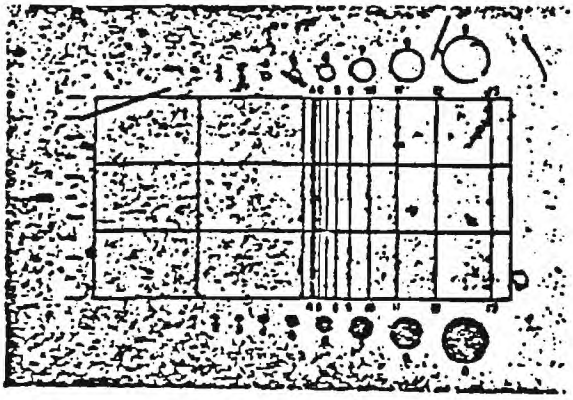

FIGURE 9

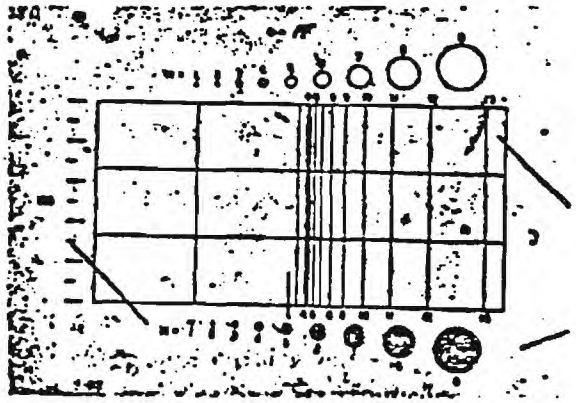

FIGURE 10

LIST OF FIGURES

(5 through 10)

APPENDIX E

OSHA ASBESTOS STANDARD

OSHA

1910.1001 - ASBESTOS

(a) Definitions

For the purpose of this section.

(1) "Asbestos" includes chrysotile, amosite, crocidolite, tremolite, anthophyllite, and actinolite.

(2) "Asbestos fibers" means asbestos fibers longer than 5 micrometers.

(b) PERMISSIBLE EXPOSURE TO AIRBORNE CONCENTRATIONS OF ASBESTOS FIBERS

(1) Standard effective July 7, 1972. The 8-hour, time-weighted average airborne concentrations of asbestos fibers to which any employee may be exposed shall not exceed five fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

(2) Standard effective July 1, 1976. The 8-hour, time-weighted average airborne concentrations of asbestos fibers to which any employee may be exposed shall not exceed two fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

(3) Ceiling concentration. No employee shall be exposed at any time to airborne concentration of asbestos fibers in excess of 10 fibers, longer than 5 micrometers, per cubic centimer of air, as determined by the method prescribed in paragraph (e) of this section.

(c) METHODS OF COMPLIANCE

(1) ENGINEERING METHODS

(i) Engineering controls. Engineering controls, such as but not limited to, isolation, enclosure, exhaust ventilation, and dust collection, shall be used to meet the exposure limits prescribed in paragraph (b) of this section.

(ii) LOCAL EXHAUST VENTILATION

(a) Local exhaust ventilation and dust collection systems shall be designed, constructed, installed, and maintained in accordance with the American National Standard Fundamentals Governing the Design and Operation of Local Exhaust Systems, ANSI Z9.2-1971, which is incorporated by reference herein.

(b) See Section 1910.6 concerning the availability of ANSI-A9.2-1971, and the maintenance of a historic file in connection therewith. The address of the American National Standards Institute is given in Section 1910.100.

(iii) PARTICULAR TOOLS

All hand-operated and power-operated tools which may produce or release asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section, such as, but not limited to, saws, scorers, abrasive wheels, and drills, shall be provided with local exhaust ventilation systems in accordance with subdivision (ii) of this subparagraph.

(2) WORK PRACTICES

(i) Wet methods. Insofar as practicable, asbestos shall be handled, mixed, applied, removed, cut, scored, or otherwise worked in a wet state sufficient to prevent the emission of airborne fibers in excess of the exposure limits prescribed in paragraph (b) of this section, unless the usefulness of the product would be diminished thereby.

(ii) Particular products and operations. No asbestos cement, mortar, coating, grout, plaster, or similar material containing asbestos shall be removed from bags, cartons, or other containers in which they are shipped, without being either wetted, or enclosed, or ventilated so as to prevent effectively the release of airborne asbestos fibers in excess of the limits prescribed in paragraph (b) of this section.

(iii) Spraying, demolition, or removal. Employees engaged in the spraying of asbestos, the removal, or demolition of pipes, structures, or equipment covered or insulated with asbestos, and in the removal or demolition of asbestos insulation or coverings shall be provided with respiratory equipment in accordance with paragraph (d) (2) (iii) of this section and with special clothing in accordance with paragraph (d) (3) of this section.

(d) PERSONAL PROTECTIVE EQUIPMENT

(1) Compliance with the exposure limits prescribed by paragraph (b) of this section may not be achieved by the use of respirators or shift rotation of employees, except:

(i) During the time period necessary to install the engineering controls and to institute the work practices required by paragraph (c) of this section;

(ii) In work situations in which the methods prescribed in paragraph (c) of this section are either technically not feasible or feasible to an extent insufficient to reduce the airborne concentrations of asbestos fibers below the limits prescribed by paragraph (b) of this section; or

(iii) In emergencies.

(iv) Where both respirators and personnel rotation are allowed by subdivision (i) and (ii), or (iii) of this subparagraph, and both are practicable, personnel rotation shall be preferred and used.

(2) Where a respirator is permitted by subparagraph (1) of this paragraph, it shall be selected from among those approved by the Bureau of Mines, Department of the Interior, or the National Institute for Occupational Safety and Health Department, of Health, Education, and Welfare, under the provisions of 30 CFR Part 11 (37 P.R. 6244, March 25, 1972), and shall be used in accordance with subdivisions (i), (ii), (iii), and (iv) of this subparagraph.

(i) Air purifying respirators. A reusable or single use air purifying respirator, or a respirator described in subdivision (ii) or (iii) of this subparagraph, shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour, time-weighted average airborne concentrations of asbestos fibers are reasonably expected to exceed no more than 10 times those limits.

(ii) Powered air purifying respirators. A full facepiece powered air purifying respirator, or a powered air purifying respirator, or a respirator described in subdivision (iii) of this subparagraph, shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour, time-weighted average concentrations of asbestos fibers are reasonably expected to exceed 10 times, but not 100 times, those limits.

(iii) Type "C" supplied-air respirators, continuous flow or pressure-demand class. A type "C" continuous flow or pressure-demand, supplied air respirator shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour, time-weighted average airborne concentrations of asbestos fibers are reasonably expected to exceed 100 times those limits.

(iv) ESTABLISHMENT OF A RESPIRATOR PROGRAM

(a) The employer shall establish a respirator program in accordance with the requirements of the American National Standard Practices for respiratory Protection, ANSI Z88.2-1969, which is incorporated by reference herein.

(b) See Section 1910.6 concerning the availability of ANSI Z88.2-1969 and the maintenance of an historic file in connection therewith. The address of the American National Standards Institute is given in Section 1910.100.

(c) No employee shall be assigned to tasks requiring the use of respirators if, based upon his most recent examination, an examining physician determines that the employee will be unable to function normally wearing a respirator, or that the safety or health of the employee or other employees will be impaired by his use of the respirator. Such employee shall be rotated to another job or given the opportunity to transfer to a different position whose duties he is able to perform with the same employer, in the same geographical area and with the same seniority, status, and rate of pay he had just prior to such transfer, if such a different position is available.

(3) Special Clothing: The employer shall provide, and require the use of, special clothing, such as coveralls or similar whole body clothing, head coverings, gloves, and foot coverings for any employee exposed to airborne concentrations of asbestos fibers, which exceed the ceiling level prescribed in paragraph (b) of this section.

(4) Change rooms:

(i) At any fixed place of employment exposed to airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section, the employer shall provide change rooms for employees working regularly at the place.

(ii) Clothes lockers: The employer shall provide two separate lockers or containers for each employee, so separated or isolated as to prevent contamination of the employee's street clothes from his work clothes.

(iii) Laundering:

(a) Laundering of asbestos-contaminated clothing shall be done so as to prevent the release of airborne asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section.

(b) Any employer who gives asbestos-contaminated clothing to another person for laundering shall inform such person of the requirement in (a) of this subdivision to effectively prevent the release of airborne asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section.

(c) Contaminated clothing shall be transported in sealed impermeable bags, or other closed, impermeable bags, or other closed, impermeable containers, and labeled in accordance with paragraph (g) of this section.

(e) METHOD OF MEASUREMENT

All determinations of airborne concentrations of asbestos fibers shall be made by the membrane filter method at 400-450 x (magnification) (4 millimeter objective) with phase contrast illumination.

(f) MONITORING

(1) Initial determinations. Within 6 months of the publication of this section, every employer shall cause every place of employment where asbestos fibers are released to be monitoried in such a way as to determine whether every employee's exposure to asbestos fibers is below the limits prescribed in paragraph (b) of this section. If the limits are exceeded, the employer shall immediately undertake a compliance program in accordance with paragraph (c) of this section.

(2) Personal Monitoring

(i) Samples shall be collected from within the breathing zone of the employees, on membrane filters of 0.8 micrometer porosity mounted in an open-face filter holder. Samples shall be taken for the determination of the 8-hour, time-weighted average airborne concentrations and of the ceiling concentrations of asbestos fibers.

(ii) Sampling frequency and patterns. After the initial determinations required by subparagraph (1) of this paragraph, samples shall be of such frequency and pattern as to represent with reasonable accuracy the levels of exposure of employees. In no case shall the sampling be done at intervals greater than 6 months for employees whose exposure to asbestos may reasonably be foreseen to exceed the limits prescribed by paragraph (b) of this section.

(3) Environmental monitoring

(i) Samples shall be collected from areas of a work environment which are representative of the airborne concentrations of asbestos fibers which may reach the breathing zone of employees. Samples shall be collected on a membrane filter of 0.8 micrometer porosity mounted in an open-face filter holder. Samples shall be taken for the determination of the 8-hour, time-weighted average airborne concentrations and of the ceiling concentrations of asbestos fibers.

(ii) Sampling frequency and patterns. After the initial determinations required by subparagraph (1) of this paragraph, samples shall be of such frequency and pattern as to represent with reasonable accuracy the levels of exposure of the employees. In no case shall sampling be at intervals greater than 6 months for employees whose exposures to asbestos may reasonably be foreseen to exceed the exposure limits prescribed in paragraph (b) of this section.

(4) Employee observation of monitoring. Affected employees, or their representatives, shall be given a reasonable opportunity to observe any monitoring required by this paragraph and shall have access to the records thereof.

(g) CAUTION SIGNS AND LABELS

(1) Caution Signs

(i) Posting. Caution signs shall be provided and displayed at each location where airborne concentrations of asbestos fibers may be in excess of the exposure limits prescribed in paragraph (b) of this section. Signs shall be posted at such a distance from such a location so that an employee may read the signs and take necessary protective steps before entering the area marked by the signs. Signs shall be posted at all approaches to areas containing excessive concentrations of airborne asbestos fibers.

(ii) Sign specifications. The warning signs required by subdivision (i) of this subparagraph shall conform to the requirements of 20" x 14" vertical format signs specified in Section 1910.145(d)(4), and to this subdivision. The signs shall display the following legend in the lower panel, with letter sizes and styles of a visibility at least equal to that specified in this subdivision.

LEGEND

	NOTATION
Asbestos	1" Sans Serif, Gothic or Block
Dust Hazard	3/4" Sans Serif, Gothic or Block
Avoid Breathing Dust	1/4" Gothic
Wear Assigned Protective Equipment	1/4" Gothic
Do Not Remain in Area Unless Your Work Requires It	1/4" Gothic
Breathing Asbestos Dust May be Hazardous to Your Health	14 Point Gothic

Spacing between lines shall be at least equal to the height of the upper of any two lines.

(2) Caution Labels

(i) Labeling. Caution labels shall be affixed to all raw materials, mixtures, scrap, waste, debris, and other products containing asbestos fibers, or to their containers, except that no label is required where asbestos fibers have been modified by a bonding agent, coating, binder, or other material so that during any reasonably foreseeable use, handling, storage, disposal, processing, or transportation, no airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section will be released.

(ii) Label specifications. The caution labels required by subdivision (i) of this subparagraph shall be printed in letters of sufficient size and contrast as to be readily visible and legible. The label shall state:

CAUTION
Contains Asbestos Fibers
Avoid creating Dust
Breathing Asbestos Dust May Cause
Serious Bodily Harm

(h) HOUSEKEEPING

(1) Cleaning. All external surfaces in any place of employment shall be maintained free of accumulations of asbestos fibers if, with their dispersion, there would be an excessive concentration.

(2) Waste disposal. Asbestos waste, scrap, debris, bags, containers, equipment, and asbestos-contaminated clothing, consigned for disposal, which may produce in any reasonably foreseeable use, handling, storage, processing, disposal or transportation airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section shall be collected and disposed of in sealed impermeable bags, or other closed, impermeable containers.

(i) Recordkeeping

(1) Exposure records. Every employer shall maintain records of any personal or environmental monitoring required by this section. Records shall be maintained for a period of at least 20 years and shall be made available upon request to the Assistant Secretary of Labor for Occupational Safety and Health, the Director of the National Institute for Occupational Safety and Health, and to authorized representatives of either.

(2) Employee access. Every employee and former employee shall have reasonable access to any record required to be maintained by subparagraph (1) of this paragraph, which indicates the employee's own exposure to asbestos fibers.

(3) Employee notification. Any employee found to have been exposed at any time to airborne concentrations of asbestos fibers in excess of the limits prescribed in paragraph (b) of this section shall be notified in writing of the exposure as soon as practicable but not later than 5 days of the finding. The employee shall also be timely notified of the corrective action being taken.

(j) MEDICAL EXAMINATIONS

(1) General. The employer shall provide or make available at his cost, medical examinations relative to exposure to asbestos required by this paragraph.

(2) Preplacement. The employer shall provide or make available to each of his employees, within 30 calendar days following his first employment in an occupation exposed to airborne concentrations of asbestos fibers, a comprehensive medical examination, which shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 x 17 inches), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second (FEV 1.0).

(3) Annual examinations. On or before January 31, 1973, and at least annually thereafter, every employer shall provide, or make available, comprehensive medical examinations to each of his employees engaged in occupations exposed to airborne concentrations of asbestos fibers. Such annual examination shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 x 17 inches), history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second (FEV 1.0).

(4) Termination of employment. The employer shall provide, or make available, within 30 calendar days before or after the termination of employment of any employee engaged in an occupation exposed to airborne concentrations of asbestos fibers, a comprehensive medical examination which shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 x 17 inches), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second (FEV 1.0).

(5) Recent examinations. No medical examination is required of any employee, if adequate records show that the employee has been examined in accordance with this paragraph within the past 1-year period.

(6) Medical records.

(i) Maintenance. Employers of employees examined pursuant to this paragraph shall cause to be maintained complete and accurate records of all such medical examinations. Records shall be retained by employers for at least 20 years.

(ii) Access. Records of the medical examinations required by this paragraph shall be provided upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.20(a)-(e) and (g)-(i). These records shall also be provided upon the request to the Director of NIOSH. Any physician who conducts a medical examination required by this paragraph shall furnish to the employer of the examined employee all the information specifically required by this paragraph, and any other medical information related to occupational exposure to asbestos fibers.

APPENDIX F

EPA NATIONAL EMISSION STANDARD FOR ASBESTOS

art B—National Emission Standard for Asbestos

20 Applicability.

e provisions of this subpart are a- le to those sources specified in 2.

21 Definitions.

ms used in this subpart are defined act, in subpart A of this part, or in ection as follows:

"Asbestos" means actinolite, amo- nthophyllite, chrysotile, crocidolite, lite.

"Asbestos material" means as- or any material containing as-

"Particulate asbestos material" s finely divided particles of asbestos ial.

"Asbestos tailings" means any waste product of asbestos mining or g operations which contains as-

"Outside air" means the air out- uildings and structures.

"Visible emissions" means any ions which are visually detectable ut the aid of instruments and which in particulate asbestos material.

"Asbestos mill" means any facility ed in the conversion or any inter- te step in the conversion of asbestos nto commercial asbestos. Outside e of asbestos materials is not con- d a part of such facility.

"Commercial asbestos" means any y of asbestos which is produced by ting asbestos from asbestos ore.

"Manufacturing" means the com- of commercial asbestos, or in the f woven friction products the com- of textiles containing commercial os, with any other material(s), in- g commercial asbestos, and the sing of this combination into a ct as specified in § 61.22(c).

"Demolition" means the wrecking king out of any load-supporting tural member and any related re- g or stripping of friable asbestos ials.

"Friable asbestos material" means material that contains more than 1 nt asbestos by weight and that can umbled, pulverized, or reduced to er, when dry, by hand pressure.

"Control device asbestos waste" s any asbestos-containing waste ial that is collected in a pollution ol device.

"Renovation" means the remov- r stripping of friable asbestos ma- s used on any pipe, duct, boiler, reactor, turbine, furnace, or tural member. Operations in load-supporting structural ers are wrecked or taken out are ded.

raph (m) revised by 43 FR 26373, June 78]

"Planned renovation" means a ation operation, or a number of operations, in which the amount ible asbestos material that will be ed or stripped within a given pe- f time can be predicted. Operations re individually non-scheduled are included, provided a number of such operations can be predicted to occur during a given period of time based on operating experience.

(o) "Emergency renovation" means a renovation operation that results from a sudden, unexpected event, and is not a planned renovation. Operations necessitated by non-routine failures of equipment are included.

(p) "Adequately wetted" means sufficiently mixed or coated with water or an aqueous solution to prevent dust emissions.

(q) "Removing" means taking out friable asbestos materials used on any pipe, duct, boiler, tank, reactor, turbine, furnace, or structural member from any building, structure, facility, or installation.

(r) "Stripping" means taking off friable asbestos materials from any pipe, duct, boiler, tank, reactor, turbine, furnace, or structural member.

[Paragraph (q) and (r) revised by 43 FR 26373, June 19, 1978]

(s) "Fabricating" means any processing of a manufactured product containing commercial asbestos, with the exception of processing at temporary sites for the construction or restoration of buildings, structures, facilities or installations.

(t) "Inactive waste disposal site" means any disposal site or portion thereof where additional asbestos-containing waste material will not be deposited and where the surface is not disturbed by vehicular traffic.

(u) "Active waste disposal site" means any disposal site other than an inactive site.

(v) "Roadways" means surfaces on which motor vehicles travel including, but not limited to, highways, roads, streets, parking areas, and driveways.

(w) "Asbestos-containing waste material" means any waste which contains commercial asbestos and is generated by a source subject to the provisions of this subpart, including asbestos mill tailings, control device asbestos waste, friable asbestos waste material, and bags or containers that previously contained commercial asbestos.

[40 FR 48292, October 14, 1975]

(x) "Structural member" means any load-supporting member, such as beams and load-supporting walls; or any non-load-supporting member, such as ceilings and non-load-supporting walls.

[42 FR 12127, March 2, 1977]

61.22 Emission standard.

(a) *Asbestos mills:* There shall be no visible emissions to the outside air from any asbestos mill except as provided in paragraph (f) of this section.

[39 FR 15936, May 3, 1974]

(b) *Roadways:* The surfacing of roadways with asbestos tailings or with asbestos-containing waste that is generated by any source subject to paragraphs (c), (d), (e) or (h), of this section is prohibited, except for temporary roadways on an area of asbestos ore deposits. The deposition of asbestos tailings or asbestos-containing waste on roadways covered with snow or ice is considered "surfacing."

(c) *Manufacturing:* There shall be no visible emissions to the outside air, except as provided in paragraph (f) of this section, from any of the following operations if they use commercial asbestos or from any building or structure in which such operations are conducted.

[40 FR 48292, October 14, 1975]

(1) The manufacture of cloth, cord, wicks, tubing, tape, twine, rope, thread, yarn, roving, lap, or other textile materials.

(2) The manufacture of cement products.

(3) The manufacture of fireproofing and insulating materials.

(4) The manufacture of friction products.

(5) The manufacture of paper, millboard, and felt.

(6) The manufacture of floor tile.

(7) The manufacture of paints, coatings, caulks, adhesives, sealants.

(8) The manufacture of plastics and rubber materials.

(9) The manufacture of chlorine.

(10) The manufacture of shotgun shells.

(11) The manufacture of asphalt concrete.

(d) *Demolition and renovation.* The requirements of this paragraph shall apply to any owner or operator of a demolition or renovation operation who intends to demolish any institutional, commercial, or industrial building (including apartment buildings having more than four dwelling units), structure, facility, installation, or portion thereof which contains any pipe, duct, boiler, tank, reactor, turbine, furnace, or structural member that is covered or coated with friable asbestos materials, except as provided in paragraph (d)(1) of this section; or who intends to renovate any institutional, commercial, or industrial building, structure, facility, installation, or portion thereof where more than 80 meters (ca. 260 feet) of pipe covered or coated with friable asbestos materials are stripped or removed, or more than 15 square meters, (ca. 160 square feet) of friable asbestos materials used to cover or coat any duct, boiler, tank, reactor, turbine, furnace, or structural member are stripped or removed.

(1) (i) The owner or operator of a demolition operation is exempted from the requirements of this paragraph: *Provided,* (A) The amount of friable asbestos materials in the building or portion thereof to be demolished is less than 80 meters (ca. 260 feet) used on pipes, and less than 15 square meters (ca. 160 square feet) used on any duct, boiler, tank, reactor, turbine, furnace, or structural member, and (B) the notification requirements of paragraph (d)(1)(ii) are met.

(ii) Written notification shall be postmarked or delivered to the Administrator at least 20 days prior to com-

mencement of demolition and shall include the information required by paragraph (d)(2) of this section, with the exception of the information required by paragraphs (d)(2) (iii), (vi), (vii), (viii), and (ix) of this section, and shall state the measured or estimated amount of friable asbestos materials which is present. Techniques of estimation shall be explained.

[Paragraph (d) revised by 43 FR 26374, June 19, 1978]

(2) Written notice of intention to demolish or renovate shall be provided to the Administrator by the owner or operator of the demolition or renovation operation. Such notice shall be postmarked or delivered to the Administrator at least 10 days prior to commencement of demolition, or as early as possible prior to commencement of emergency demolition subject to paragraph (d)(6) of this section, and as early as possible prior to commencement of renovation. Such notice shall include the following information:

(i) Name of owner or operator.

(ii) Address of owner or operator.

(iii) Description of the building, structure, facility, or installation to be demolished or renovated, including the size, age, and prior use of the structure, and the approximate amount of friable asbestos materials present.

[Paragraph (iii) revised by 43 FR 26374, June 19, 1978]

(iv) Address or location of the building, structure, facility, or installation.

(v) Scheduled starting and completion dates of demolition or renovation.

(vi) Nature of planned demolition or renovation and method(s) to be employed.

(vii) Procedures to be employed to meet the requirements of this paragraph and paragraph (j) of this section.

(viii) The name and address or location of the waste disposal site where the friable asbestos waste will be deposited.

(ix) Name, title, and authority of the State or local governmental representative who has ordered a demolition which is subject to paragraph (d)(6) of this section.

(3)(i) For purposes of determining whether a planned renovating operation constitutes a renovation within the meaning of this paragraph, the amount of friable asbestos material to be removed or stripped shall be:

(A) For planned renovating operations involving individually non-scheduled operations, the additive amount of friable asbestos material that can be predicted will be removed or stripped at a source over the maximum period of time for which a prediction can be made. The period shall be not less than 30 days and not longer than one year.

(B) For each planned renovating operation not covered by paragraph (d)(3)(i)(A), the total amount of friable asbestos material that can be predicted will be removed or stripped at a source.

(ii) For purposes of determining whether an emergency renovating operation constitutes a renovation within the meaning of this paragraph, the amount of friable asbestos material to be removed or stripped shall be the total amount of friable asbestos material that will be removed or stripped as a result of the sudden, unexpected event that necessitated the renovation.

(4) The following procedures shall be used to prevent emissions of particulate asbestos material to outside air:

(i) Friable asbestos materials, used on any pipe, duct, boiler, tank, reactor, turbine, furnace, or structural member, shall be removed from any building, structure, facility or installation subject to this paragraph. Such removal shall occur before wrecking or dismantling of any portion of such building, structure, facility, or installation that would break up the friable asbestos materials and before wrecking or dismantling of any other portion of such building, structure, facility, or installation, that would preclude access to such materials for subsequent removal. Removal of friable asbestos materials used on any pipe, duct, or structural member which are encased in concrete or other similar structural material is not required prior to demolition, but such materials shall be adequately wetted whenever exposed during demolition.

(ii) Friable asbestos materials used on pipes, ducts, boilers, tanks, reactors, turbines, furnaces, or structural members shall be adequately wetted during stripping, except as provided in paragraphs (d)(4)(iv), (d)(4)(vi), or (d)(vii) of this section.

(iii) Pipes, ducts, boilers, tanks, reactors, turbines, furnaces, or structural members that are covered or coated with friable asbestos materials may be taken out of any building, structure, facility, or installation subject to this paragraph as units or in sections provided the friable asbestos materials exposed during cutting or disjoining are adequately wetted during the cutting or disjoining operation. Such units shall not be dropped or thrown to the ground, but shall be carefully lowered to ground level.

(iv) The stripping of friable asbestos materials used on any pipe, duct, boiler, tank, reactor, turbine, furnace, or structural member that has been removed as a unit or in sections as provided in paragraph (d)(4)(iii) of this section shall be performed in accordance with paragraph (d)(4)(ii) of this section. Rather than comply with the wetting requirement, a local exhaust ventilation and collection system may be used to prevent emissions to the outside air. Such local exhaust ventilation systems shall be designed and operated to capture the asbestos particulate matter produced by the stripping of friable asbestos materials. There shall be no visible emissions to the outside air from such local exhaust ventilation and collection systems except as provided in paragraph (f) of this section.

[4(i)–(iv) revised by 43 FR 26374, June 19, 1978]

(v) All friable asbestos materials that have been removed or stripped shall be adequately wetted to ensure that such materials remain wet during all remaining stages of demolition or renovation and related handling operations. Such materials shall not be dropped or thrown to the ground or a lower floor. Such materials that have been removed or stripped more than 50 feet above ground level, except those materials removed as units or in sections, shall be transported to the ground via dust-tight chutes or containers.

(vi) Except as specified below, the wetting requirements of this paragraph are suspended when the temperature at the point of wetting is below 0°C (32°F). When friable asbestos materials are not wetted due to freezing temperatures, such materials on pipes, ducts, boilers, tanks, reactors, turbines, furnaces, or structural members shall, to the maximum extent possible, be removed as units or in sections prior to wrecking. In no case shall the requirements of paragraphs (d)(4)(iv) or (d)(4)(v) be suspended due to freezing temperatures.

(vii) For renovation operations, local exhaust ventilation and collection systems may be used, instead of wetting as specified in paragraph (d)(4)(ii), to prevent emissions of particulate asbestos material to outside air when damage to equipment resulting from the wetting would be unavoidable. Upon request and supply of adequate information, the Administrator will determine whether damage to equipment resulting from wetting to comply with the provisions of this paragraph would be unavoidable. Such local exhaust ventilation systems shall be designed and operated to capture the asbestos particulate matter produced by the stripping and removal of friable asbestos material. There shall be no visible emissions to the outside air from such local exhaust ventilation and collection systems, except as provided in paragraph (f) of this section.

(5) Sources subject to this paragraph are exempt from the requirements of §§ 61.05(a), 61.07, and 61.09.

(6) The demolition of a building, structure, facility, or installation, pursuant to an order of an authorized representative of a State or local governmental agency, issued because that building is structurally unsound and in danger of imminent collapse is exempt from all but the following requirements of paragraph (d) of this section:

(i) The notification requirements specified by paragraph (d)(2) of this section;

(ii) The requirements on stripping of friable asbestos materials from previously removed units or sections as specified in paragraph (d)(4)(iv) of this section;

(iii) The wetting, as specified by paragraph (d)(4)(v) of this section, of friable asbestos materials that have been removed or stripped;

(iv) The portion of the structure being demolished that contains friable asbestos materials shall be adequately wetted during the wrecking operation.

[39 FR 15936, May 3, 1974; 40 FR 48292, October 14, 1975]

(e) *Spraying.* There shall be no visible emissions to the outside air from the spray-on application of materials containing more than 1 percent asbes-

[Sec. 61.22(e)]

n a dry weight basis, used on nent and machinery, except as ed in paragraph (f) of this sec- Materials sprayed on buildings, ures, structural members, pipes, nduits shall contain less than 1 it asbestos on a dry weight basis.

raph (e) revised by 43 FR 26374, June 78]

Sources subject to this paragraph exempt from the requirements of (a), § 61.07, and § 61.09.

Any owner or operator who in- to spray asbestos materials contain more than 1 percent as- on a dry weight basis on equip- and machinery shall report such ion to the Administrator at least s prior to the commencement of praying operation. Such report include the following informa-

Name of owner or operator.

Address of owner or operator.

Location of spraying operation.

Procedures to be followed to meet quirements of this paragraph.

The spray-on application of ma- s in which the asbestos fibers are sulated with a bituminous or re- s binder during spraying and are not friable after drying is pted from the requirements of raphs (e) and (e)(2) of this sec-

graphs (2) and (3) revised by 43 FR June 19, 1978]

Rather than meet the no-visible- ion requirements as specified by raphs (a), (c), (d), (e), (h), (j), k) of this section, an owner or op- r may elect to use the methods spec- by § 61.23 to clean emissions con- ng particulate asbestos material be- such emissions escape to, or are d to, the outside air.

Where the presence of uncombined r is the sole reason for failure to the no-visible-emission require- of paragraphs (a), (c), (d), (e), (j), or (k) of this section, such fail- hall not be a violation of such emis- requirements.

Fabricating: There shall be no e emissions to the outside air, ex- s provided in paragraph (f) of this n, from any of the following op- ns if they use commercial asbestos om any building or structure in such operations are conducted.

The fabrication of cement building cts.

The fabrication of friction prod- except those operations that pri- install asbestos friction materials tor vehicles.

The fabrication of cement or sili- oard for ventilation hoods; ovens; cal panels; laboratory furniture; bulkheads, partitions and ceilings for marine construction; and flow control devices for the molten metal industry.

(i) Insulating: Molded insulating materials which are friable and wet-applied insulating materials which are friable after drying, installed after the effective date of these regulations, shall contain no commercial asbestos. The provisions of this paragraph do not apply to insulating materials which are spray applied; such materials are regulated under § 61.22(e).

(j) Waste disposal for manufacturing, fabricating, demolition, renovation and spraying operations: The owner or operator of any source covered under the provisions of paragraphs (c), (d), (e), or (h) of this section shall meet the following standards:

(1) There shall be no visible emissions to the outside air, except as provided in paragraph (j)(3) of this section, during the collection; processing, including incineration; packaging; transporting; or deposition of any asbestos-containing waste material which is generated by such source.

(2) All asbestos-containing waste material shall be deposited at waste disposal sites which are operated in accordance with the provisions of § 61.25.

(3) Rather than meet the requirement of paragraph (j)(1) of this section, an owner or operator may elect to use either of the disposal methods specified under (j)(3)(i) and (ii) of this section, or an alternative disposal method which has received prior approval by the Administrator:

(i) Treatment of asbestos-containing waste material with water:

(A) Control device asbestos waste shall be thoroughly mixed with water into a slurry and other asbestos-containing waste material shall be adequately wetted. There shall be no visible emissions to the outside air from the collection, mixing and wetting operations, except as provided in paragraph (f) of this section.

(B) After wetting, all asbestos-containing waste material shall be sealed into leak-tight containers while wet, and such containers shall be deposited at waste disposal sites which are operated in accordance with the provisions of § 61.25.

(C) The containers specified under paragraph (j)(3)(i)(B) of this section shall be labeled with a warning label that states:

CAUTION
Contains Asbestos
Avoid Opening or Breaking Container
Breathing Asbestos is Hazardous
to Your Health

Alternatively, warning labels specified by Occupational Safety and Health Standards of the Department of Labor, Occupational Safety and Health Administration (OSHA) under 29 CFR 1910.-93a(g)(2)(ii) may be used.

(ii) Processing of asbestos-containing waste material into non-friable forms:

(A) All asbestos-containing waste material shall be formed into non-friable pellets or other shapes and deposited at waste disposal sites which are operated in accordance with the provisions of § 61.25.

(B) There shall be no visible emissions to the outside air from the collection and processing of asbestos-containing waste material, except as specified in paragraph (f) of this section.

(4) For the purposes of this paragraph (j), the term all asbestos-containing waste material as applied to demolition and renovation operations covered by paragraph (d) of this section includes only friable asbestos waste and control device asbestos waste.

(k) Waste disposal for asbestos mills: The owner or operator of any source covered under the provisions of paragraph (a) of this section shall meet the following standard:

(1) There shall be no visible emissions to the outside air, except as provided in paragraph (k)(3) of this section, during the collection, processing, packaging, transporting or deposition of any asbestos-containing waste material which is generated by such source.

(2) All asbestos-containing waste material shall be deposited at waste disposal sites which are operated in accordance with the provisions of § 61.25.

(3) Rather than meet the requirement of paragraph (k)(1) of this section, an owner or operator may elect to meet the following requirements in paragraphs (k)(3)(i) and (ii), or use an alternative disposal method which has received prior approval by the Administrator:

(i) There shall be no visible emissions to the outside air from the transfer of control device asbestos waste to the tailings conveyor, except as provided in paragraph (f) of this section. Such waste shall be subsequently processed either as specified in paragraph (k)(3)(ii) of this section or as specified in paragraph (j)(3) of this section.

(ii) All asbestos-containing waste material shall be adequately mixed, with a wetting agent recommended by the manufacturer of the agent to effectively wet dust and tailings, prior to deposition at a waste disposal site. Such agent shall be used as recommended for the particular dust by the manufacturer of the agent. There shall be no discharge of visible emissions to the outside air from the wetting operation except as specified in paragraph (f) of this section. Wetting may be suspended when the ambient temperature at the waste disposal site is less than −9.5°C (ca. 15°F). The ambient air temperature shall be determined by an appropriate measurement method with an accuracy of ±1°C (±2°F) and recorded at least at hourly intervals during the period that the operation of the wetting system is suspended. Records of

such temperature measurements shall be retained at the source for a minimum of two years and made available for inspection by the Administrator.

(l) The owner of any inactive waste disposal site, which was operated by sources covered under § 61.22 (a), (c) or (h) and where asbestos-containing waste material produced by such sources was deposited, shall meet the following standards:

(1) There shall be no visible emissions to the outside air from an inactive waste disposal site subject to this paragraph, except as provided in paragraph (l)(5) of this section.

(2) Warning signs shall be displayed at all entrances, and along the property line of the site or along the perimeter of the sections of the site where asbestos-containing waste material was deposited, at intervals of 100 m (ca. 330 ft) or less, except as specified in paragraph (l)(4) of this section. Signs shall be posted in such a manner and location that a person may easily read the legend. The warning signs required by this paragraph shall conform to the requirements of 20" x 14" upright format signs specified in 29 CFR 1910.145(d)(4) and this paragraph. The signs shall display the following legend in the lower panel, with letter sizes and styles of a visibility at least equal to those specified in this paragraph.

LEGEND

ASBESTOS WASTE DISPOSAL SITE

Do Not Create Dust

Breathing Asbestos is Hazardous to Your Health

Notation

1" Sans Serif, Gothic or Block

¼" Sans Serif, Gothic or Block

14 Point Gothic

Spacing between lines shall be at least equal to the height of the upper of the two lines.

(3) The perimeter of the site shall be fenced in a manner adequate to deter access by the general public, except as specified in paragraph (l)(4) of this section.

(4) Warning signs and fencing are not required where the requirements of paragraphs (1)(5) (i) or (ii) of this section are met, or where a natural barrier adequately deters access by the general public. Upon request and supply of appropriate information, the Administrator will determine whether a fence or a natural barrier adequately deters access to the general public.

(5) Rather than meet the requirement of paragraph (1)(1) of this section, an owner may elect to meet the requirements of this paragraph or may use an alternative control method for emissions from inactive waste disposal sites which has received prior approval by the Administrator.

(i) The asbestos-containing waste material shall be covered with at least 15 centimeters (ca. 6 inches) of compacted non-asbestos-containing material, and a cover of vegetation shall be grown and maintained on the area adequate to prevent exposure of the asbestos-containing waste material; or

(ii) The asbestos-containing waste material shall be covered with at least 60 centimeters (ca. 2 feet) of compacted non-asbestos-containing material and maintained to prevent exposure of the asbestos-containing waste; or

(iii) For inactive waste disposal sites for asbestos tailings, a resinous or petroleum-based dust suppression agent which effectively binds dust and controls wind erosion shall be applied. Such agent shall be used as recommended for the particular asbestos tailings by the dust suppression agent manufacturer. Other equally effective dust suppression agents may be used upon prior approval by the Administrator. For purposes of this paragraph, waste crankcase oil is not considered a dust suppression agent.

[40 FR 48292, October 14, 1975]

§ 61.23 Air-cleaning.

If air-cleaning is elected, as permitted by §§ 61.22(f) and 61.22(d)(4)(iv), the requirements of this section must be met.

[40 FR 48292, October 14, 1975]

(a) Fabric filter collection devices must be used, except as noted in paragraphs (b) and (c) of this section. Such devices must be operated at a pressure drop of no more than 4 inches water gage, as measured across the filter fabric. The airflow permeability, as determined by ASTM method D737–69, must not exceed 30 $ft^3/min/ft^2$ for woven fabrics or 35 $ft^3/min/ft^2$ for felted fabrics, except that 40 $ft^3/min/ft^2$ for woven and 45 $ft^3/min/ft^2$ for felted fabrics is allowed for filtering air from asbestos ore dryers. Each square yard of felted fabric must weigh at least 14 ounces and be at least one-sixteenth inch thick throughout. Synthetic fabrics must not contain fill yarn other than that which is spun.

(b) If the use of fabric filters creates a fire or explosion hazard, the administrator may authorize the use of wet collectors designed to operate with a unit contacting energy of at least 40 inches water gage pressure.

(c) The administrator may authorize the use of filtering equipment other than that described in paragraphs (a) and (b) of this section if the owner or operator demonstrates to the satisfaction of the administrator that the filtering of particulate asbestos material is equivalent to that of the described equipment.

(d) All air-cleaning equipment authorized by this section must be properly installed, used, operated, and maintained. Bypass devices may be used only during upset or emergency conditions and then only for so long as it takes to shut down the operation generating the particulate asbestos material.

§ 61.24 Reporting.

The owner or operator of any existing source to which this subpart is applicable shall, within 90 days after the effective date, provide the following information to the administrator:

(a) A description of the emission control equipment used for each process;

(b) If a fabric filter device is used to control emissions, the pressure drop across the fabric filter in inches water gage.

(1) If the fabric filter device utilizes a woven fabric, the airflow permeability in $ft^3/min/ft^2$; and, if the fabric is synthetic, indicate whether the fill yarn is spun or not spun.

(2) If the fabric filter device utilizes a felted fabric, the density in oz/yd^3, the minimum thickness in inches, and the airflow permeability in $ft^3/min/ft^2$.

(c) For sources subject to §§ 61.22(j) and 61.22(k):

(1) A brief description of each process that generates asbestos-containing waste material.

(2) The average weight of asbestos-containing waste material disposed of, measured in kg/day.

(3) The emission control methods used in all stages of waste disposal.

(4) The type of disposal site or incineration site used for ultimate disposal, the name of the site operator, and the name and location of the disposal site.

(d) For sources subject to § 61.22(l):

(1) A brief description of the site.

(2) The method or methods used to comply with the standard, or alternative procedures to be used.

(e) Such information shall accompany the information required by § 61.10. The information described in this section shall be reported using the format of Appendix A of this part.

[40 FR 48292, October 14, 1975]

§ 61.25 Waste disposal sites.

In order to be an acceptable site for disposal of asbestos-containing waste material under § 61.22 (j) and (k), an active waste disposal site shall meet the requirements of this section.

(a) There shall be no visible emissions to the outside air from any active waste disposal site where asbestos-containing waste material has been deposited, except as provided in paragraph (e) of this section.

(b) Warning signs shall be displayed at all entrances, and along the property line of the site or along the perimeter of the sections of the site where asbestos-containing waste material is deposited, at intervals of 100 m (ca. 330 ft) or less except as specified in paragraph (d) of this section. Signs shall be posted in such

cer and location that a person may read the legend. The warning required by this paragraph shall m to the requirements of 20" x 14" t format signs specified in 29 CFR 15(d)(4) and this paragraph. The hall display the following legend lower panel, with letter sizes and of a visibility at least equal to specified in this paragraph.

LEGEND

ASBESTOS WASTE DISPOSAL SITE

Do Not Create Dust

Breathing Asbestos
is Hazardous to Your Health

Notation

1" Sans Serif, Gothic or Block

¼" Sans Serif, Gothic or Block

14 Point Gothic

g between lines shall be at least to the height of the upper of the es.

The perimeter of the disposal site e fenced in order to adequately ccess to the general public except cified in paragraph (d) of this

Warning signs and fencing are uired where the requirements of aph (e)(1) of this section are r where a natural barrier ade- deters access to the general Upon request and supply of ap- te information, the Administra- determine whether a fence or a barrier adequately deters access eneral public.

Rather than meet the require- f paragraph (a) of this section, an or operator may elect to meet uirements of paragraph (e)(1) or of this section, or may use an al- ve control method for emissions ctive waste disposal sites which ceived prior approval by the strator.

At the end of each operating day, least once every 24-hour period he site is in continuous operation, estos-containing waste material was deposited at the site during rating day or previous 24-hour shall be covered with at least 15 ters (ca. 6 inches) of compacted estos-containing material.

t the end of each operating day, east once every 24-hour period he disposal site is in continuous on, the asbestos-containing waste l which was deposited at the site he operating day or previous 24- riod shall be covered with a res- petroleum-based dust suppres- nt which effectively binds dust trols wind erosion. Such agent used as recommended for the ar dust by the dust suppression agent manufacturer. Other equally effective dust suppression agents may be used upon prior approval by the Administrator. For purposes of this paragraph, waste crankcase oil is not considered a dust suppression agent.

[40 FR 48292, October 14, 1975]

(Sec. 114 of the Clean Air Act as amended (42 U.S.C. 7414))

Subpart C—National Emission Standard for Beryllium

§ 61.30 Applicability.

The provisions of this subpart are applicable to the following stationary sources:

(a) Extraction plans, ceramic plants, foundries, incinerators, and propellant plants which process beryllium ore, beryllium, beryllium oxide, beryllium alloys, or beryllium-containing waste.

(b) Machine shops which process beryllium, beryllium oxides, or any alloy when such alloy contains more than 5 percent beryllium by weight.

§ 61.31 Definitions.

Terms used in this subpart are defined in the act, in subpart A of this part, or in this section as follows:

(a) "Beryllium" means the element beryllium. Where weights or concentrations are specified, such weights or concentrations apply to beryllium only, excluding the weight or concentration of any associated elements.

(b) "Extraction plant" means a facility chemically processing beryllium ore to beryllium metal, alloy, or oxide, or performing any of the intermediate steps in these processes.

(c) "Beryllium ore" means any naturally occurring material mined or gathered for its beryllium content.

(d) "Machine shop" means a facility performing cutting, grinding, turning, honing, milling, deburring, lapping, electrochemical machining, etching, or other similar operations.

(e) "Ceramic plant" means a manufacturing plant producing ceramic items.

(f) "Foundry" means a facility engaged in the melting or casting of beryllium metal or alloy.

(g) "Beryllium-containing waste" means material contaminated with beryllium and/or beryllium compounds used or generated during any process or operation performed by a source subject to this subpart.

(h) "Incinerator" means any furnace used in the process of burning waste for the primary purpose of reducing the volume of the waste by removing combustible matter.

(i) "Propellant" means a fuel and oxidizer physically or chemically combined which undergoes combustion to provide rocket propulsion.

(j) "Beryllium alloy" means any metal to which beryllium has been added in order to increase its beryllium content and which contains more than 0.1 percent beryllium by weight.

(k) "Propellant plant" means any facility engaged in the mixing, casting, or machining of propellant.

§ 61.32 Emission standard.

(a) Emissions to the atmosphere from stationary sources subject to the provisions of this subpart shall not exceed 10 grams of beryllium over a 24-hour period, except as provided in paragraph (b) of this section.

(b) Rather than meet the requirement of paragraph (a) of this section, an owner or operator may request approval from the Administrator to meet an ambient concentration limit on beryllium in the vicinity of the stationary source of 0.01 $\mu g/m^3$, averaged over a 30-day period.

(1) Approval of such requests may be granted by the Administrator provided that:

(i) At least 3 years of data is available which in the judgment of the Administrator demonstrates that the future ambient concentrations of beryllium in the vicinity of the stationary source will not exceed 0.01 $\mu g/m^3$, averaged over a 30-day period. Such 3-year period shall be the 3 years ending 30 days before the effective date of this standard.

(ii) The owner or operator requests such approval in writing within 30 days after the effective date of this standard.

(iii) The owner or operator submits a report to the Administrator within 45 days after the effective date of this standard which report includes the following information:

(a) Description of sampling method including the method and frequency of calibration.

(b) Method of sample analysis.

(c) Averaging technique for determining 30-day average concentrations.

(d) Number, identity, and location (address, coordinates, or distance and heading from plant) of sampling sites.

(e) Ground elevations and height above ground of sampling inlets.

(f) Plant and sampling area plots showing emission points and sampling sites. Topographic features significantly affecting dispersion including plant building heights and locations shall be included.

(g) Information necessary for estimating dispersion including stack height, inside diameter, exit gas temperature, exit velocity or flow rate, and beryllium concentration.

(h) A description of data and procedures (methods or models) used to de-

APPENDIX G

OSHA RESPIRATORY PROTECTION STANDARD

OCCUPATIONAL SAFETY AND HEALTH STANDARDS
SUBPART I — PERSONAL PROTECTIVE EQUIPMENT

(Code of Federal Regulations, Title 29, Chapter XVII, Part 1910, 36 FR 10466, May 29, 1971; amended at 36 FR 15105, August 13, 1971; 37 FR 22231, October 18, 1972; republished at 39 FR 23502, June 27, 1974; standard provision revoked at 43 FR 49726, October 24, 1978)

Subpart I—Personal Protective Equipment

§ 1910.132 General requirements.

(a) *Application.* Protective equipment, including personal protective equipment for eyes, face, head, and extremities, protective clothing, respiratory devices, and protective shields and barriers, shall be provided, used, and maintained in a sanitary and reliable condition wherever it is necessary by reason of hazards of processes or environment, chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical contact.

(b) *Employee-owned equipment.* Where employees provide their own protective equipment, the employer shall be responsible to assure its adequacy, including proper maintenance, and sanitation of such equipment.

(c) *Design.* All personal protective equipment shall be of safe design and construction for the work to be performed.

§ 1910.133 Eye and face protection.

(a) *General.* (1) Protective eye and face equipment shall be required where there is a reasonable probability of injury that can be prevented by such equipment. In such cases, employers shall make conveniently available a type of protector suitable for the work to be performed, and employees shall use such protectors. No unprotected person shall knowingly be subjected to a hazardous environmental condition. Suitable eye protectors shall be provided where machines or operations present the hazard of flying objects, glare, liquids, injurious radiation, or a combination of these hazards.

(2) Protectors shall meet the following minimum requirements:

(i) They shall provide adequate protection against the particular hazards for which they are designed.

(ii) They shall be reasonably comfortable when worn under the designated conditions.

(iii) They shall fit snugly and shall not unduly interfere with the movements of the wearer.

(iv) They shall be durable.

(v) They shall be capable of being disinfected.

(vi) They shall be easily cleanable.

(vii) Protectors should be kept clean and in good repair.

(3) Persons whose vision requires the use of corrective lenses in spectacles, and who are required by this standard to wear eye protection, shall wear goggles or spectacles of one of the following types:

(i) Spectacles whose protective lenses provide optical correction.

(ii) Goggles that can be worn over corrective spectacles without disturbing the adjustment of the spectacles.

(iii) Goggles that incorporate corrective lenses mounted behind the protective lenses.

(4) Every protector shall be distinctly marked to facilitate identification only of the manufacturer.

(5) When limitations or precautions are indicated by the manufacturer, they shall be transmitted to the user and care taken to see that such limitations and precautions are strictly observed.

(6) Design, construction, testing, and use of devices for eye and face protection shall be in accordance with American National Standard for Occupational and Educational Eye and Face Protection, Z87.1–1968.

§ 1910.134 Respiratory protection.

(a) *Permissible practice.* (1) In the control of those occupational diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors, the primary objective shall be to prevent atmospheric contamination. This shall be accomplished as far as feasible by accepted engineering control measures (for example, enclosure or confinement of the operation, general and local ventilation, and substitution of less toxic materials). When effective engineering controls are not feasible, or while they are being instituted, appropriate respirators shall be used pursuant to the following requirements.

(2) Respirators shall be provided by the employer when such equipment is necessary to protect the health of the employee. The employer shall provide the respirators which are applicable and suitable for the purpose intended. The employer shall be responsible for the establishment and maintenance of a respiratory protective program which shall include the requirements outlined in paragraph (b) of this section.

(3) The employee shall use the provided respiratory protection in accordance with instructions and training received.

(b) *Requirements for a minimal acceptable program.* (1) Written standard operating procedures governing the selection and use of respirators shall be established.

(2) Respirators shall be selected on the basis of hazards to which the worker is exposed.

(3) The user shall be instructed and trained in the proper use of respirators and their limitations.

(4) Where practicable, the respirators should be assigned to individual workers for their exclusive use.

(5) Respirators shall be regularly cleaned and disinfected. Those issued for

he exclusive use of one worker should be leaned after each day's use, or more ften if necessary. Those used by more han one worker shall be thoroughly leaned and disinfected after each use.

(6) Respirators shall be stored in a onvenient, clean, and sanitary location.

(7) Respirators used routinely shall e inspected during cleaning. Worn or leteriorated parts shall be replaced. Respirators for emergency use such as self-contained devices shall be thoroughly nspected at least once a month and after ach use.

(8) Appropriate surveillance of work rea conditions and degree of employee xposure or stress shall be maintained.

(9) There shall be regular inspection nd evaluation to determine the continued effectiveness of the program.

(10) Persons should not be assigned o tasks requiring use of respirators unless it has been determined that they are hysically able to perform the work and se the equipment. The local physician hall determine what health and physical onditions are pertinent. The respirator ser's medical status should be review. l eriodically (for instance, annually).

(11) Approved or accepted respirators hall be used when they are available. he respirator furnished shall provide dequate respiratory protection against he particular hazard for which it is esigned in accordance with standards stablished by competent authorities. The .S. Department of Interior, Bureau of lines, and the U.S. Department of Agriulture are recognized as such authorities. Although respirators listed by the .S. Department of Agriculture continue o be acceptable for protection against pecified pesticides, the U.S. Department f the Interior, Bureau of Mines, is the gency now responsible for testing and pproving pesticide respirators.

(c) *Selection of respirators.* Proper election of respirators shall be made acording to the guidance of American lational Standard Practices for Respiratory Protection Z88.2–1969.

(d) *Air quality.* (1) Compressed air, ompressed oxygen, liquid air, and liquid xygen used for respiration shall be of igh purity. Oxygen shall meet the requirements of the United States Pharmacopoeia for medical or breathing oxygen. reathing air shall meet at least the requirements of the specification for Grade breathing air as described in Compressed Gas Association Commodity pecification G–7.1–1966. Compressed xygen shall not be used in supplied-air spirators or in open circuit self-ontained breathing apparatus that have reviously used compressed air. Oxygen ust never be used with air line spirators.

(2) Breathing air may be supplied to spirators from cylinders or air mpressors.

(i) Cylinders shall be tested and mainined as prescribed in the Shipping ontainer Specification Regulations of e Department of Transportation (49 'R Part 178).

(ii) The compressor for supplying air all be equipped with necessary safety d standby devices. A breathing air-type compressor shall be used. Compressors shall be constructed and situated so as to avoid entry of contaminated air into the system and suitable in-line air purifying sorbent beds and filters installed to further assure breathing air quality. A receiver of sufficient capacity to enable the respirator wearer to escape from a contaminated atmosphere in event of compressor failure, and alarms to indicate compressor failure and overheating shall be installed in the system. If an oil-lubricated compressor is used, it shall have a high-temperature or carbon monoxide alarm, or both. If only a high-temperature alarm is used, the air from the compressor shall be frequently tested for carbon monoxide to insure that it meets the specifications in subparagraph (1) of this paragraph.

(3) Air line couplings shall be incompatible with outlets for other gas systems to prevent inadvertent servicing of air line respirators with nonrespirable gases or oxygen.

(4) Breathing gas containers shall be marked in accordance with American National Standard Method of Marking Portable Compressed Gas Containers to Identify the Material Contained, Z48.1–1954; Federal Specification BB–A–1034a, June 21, 1968, Air, Compressed for Breathing Purposes; or Interim Federal Specification GG–B–00675b, April 27, 1965, Breathing Apparatus Self-Contained.

(e) *Use of respirators.* (1) Standard procedures shall be developed for respirator use. These should include all information and guidance necessary for their proper selection, use, and care. Possible emergency and routine uses of respirators should be anticipated and planned for.

(2) The correct respirator shall be specified for each job. The respirator type is usually specified in the work procedures by a qualified individual supervising the respiratory protective program. The individual issuing them shall be adequately instructed to insure that the correct respirator is issued. Each respirator permanently assigned to an individual should be durably marked to indicate to whom it was assigned. This mark shall not affect the respirator performance in any way. The date of issuance should be recorded.

(3) Written procedures shall be prepared covering safe use of respirators in dangerous atmospheres that might be encountered in normal operations or in emergencies. Personnel shall be familiar with these procedures and the available respirators.

(i) In areas where the wearer, with failure of the respirator, could be overcome by a toxic or oxygen-deficient atmosphere, at least one additional man shall be present. Communications (visual, voice, or signal line) shall be maintained between both or all individuals present. Planning shall be such that one individual will be unaffected by any likely incident and have the proper rescue equipment to be able to assist the other(s) in case of emergency.

(ii) When self-contained breathing apparatus or hose masks with blowers are used in atmospheres immediately dangerous to life or health, standby men must be present with suitable rescue equipment.

(iii) Persons using air line respirators in atmospheres immediately hazardous to life or health shall be equipped with safety harnesses and safety lines for lifting or removing persons from hazardous atmospheres or other and equivalent provisions for the rescue of persons from hazardous atmospheres shall be used. A standby man or men with suitable self-contained breathing apparatus shall be at the nearest fresh air base for emergency rescue.

(4) Respiratory protection is no better than the respirator in use, even though it is worn conscientiously. Frequent random inspections shall be conducted by a qualified individual to assure that respirators are properly selected, used, cleaned, and maintained.

(5) For safe use of any respirator, it is essential that the user be properly instructed in its selection, use, and maintenance. Both supervisors and workers shall be so instructed by competent persons. Training shall provide the men an opportunity to handle the respirator, have it fitted properly, test its face-piece-to-face seal, wear it in normal air for a long familiarity period, and, finally, to wear it in a test atmosphere.

(i) Every respirator wearer shall receive fitting instructions including demonstrations and practice in how the respirator should be worn, how to adjust it, and how to determine if it fits properly. Respirators shall not be worn when conditions prevent a good face seal. Such conditions may be a growth of beard, sideburns, a skull cap that projects under the facepiece, or temple pieces on glasses. Also, the absence of one or both dentures can seriously affect the fit of a facepiece. The worker's diligence in observing these factors shall be evaluated by periodic check. To assure proper protection, the facepiece fit shall be checked by the wearer each time he puts on the respirator. This may be done by following the manufacturer's facepiece fitting instructions.

(ii) Providing respiratory protection for individuals wearing corrective glasses is a serious problem. A proper seal cannot be established if the temple bars of eye glasses extend through the sealing edge of the full facepiece. As a temporary measure, glasses with short temple bars or without temple bars may be taped to the wearer's head. Wearing of contact lenses in contaminated atmospheres with a respirator shall not be allowed. Systems have been developed for mounting corrective lenses inside full facepieces. When a workman must wear corrective lenses as part of the facepiece, the facepiece and lenses shall be fitted by qualified individuals to provide good vision, comfort, and a gas-tight seal.

(iii) If corrective spectacles or goggles are required, they shall be worn so as not to affect the fit of the facepiece. Proper selection of equipment will minimize or avoid this problem.

(f) *Maintenance and care of respirators.* (1) A program for maintenance and

care of respirators shall be adjusted to the type of plant, working conditions, and hazards involved, and shall include the following basic services:

(i) Inspection for defects (including a leak check),

(ii) Cleaning and disinfecting,

(iii) Repair,

(iv) Storage

Equipment shall be properly maintained to retain its original effectiveness.

(2) (i) All respirators shall be inspected routinely before and after each use. A respirator that is not routinely used but is kept ready for emergency use shall be inspected after each use and at least monthly to assure that it is in satisfactory working condition.

(ii) Self-contained breathing apparatus shall be inspected monthly. Air and oxygen cylinders shall be fully charged according to the manufacturer's instructions. It shall be determined that the regulator and warning devices function properly.

(iii) Respirator inspection shall include a check of the tightness of connections and the condition of the facepiece, headbands, valves, connecting tube, and canisters. Rubber or elastomer parts shall be inspected for pliability and signs of deterioration. Stretching and manipulating rubber or elastomer parts with a massaging action will keep them pliable and flexible and prevent them from taking a set during storage.

(iv) A record shall be kept of inspection dates and findings for respirators maintained for emergency use.

(3) Routinely used respirators shall be collected, cleaned, and disinfected as frequently as necessary to insure that proper protection is provided for the wearer. Each worker should be briefed on the cleaning procedure and be assured that he will always receive a clean and disinfected respirator. Such assurances are of greatest significance when respirators are not individually assigned to workers. Respirators maintained for emergency use shall be cleaned and disinfected after each use.

(4) Replacement or repairs shall be done only by experienced persons with parts designed for the respirator. No attempt shall be made to replace components or to make adjustment or repairs beyond the manufacturer's recommendations. Reducing or admission valves or regulators shall be returned to the manufacturer or to a trained technician for adjustment or repair.

(5) (i) After inspection, cleaning, and necessary repair, respirators shall be stored to protect against dust, sunlight, heat, extreme cold, excessive moisture, or damaging chemicals. Respirators placed at stations and work areas for emergency use should be quickly accessible at all times and should be stored in compartments built for the purpose. The compartments should be clearly marked. Routinely used respirators, such as dust respirators, may be placed in plastic bags. Respirators should not be stored in such places as lockers or tool boxes unless they are in carrying cases or cartons.

(ii) Respirators should be packed or stored so that the facepiece and exhalation valve will rest in a normal position and function will not be impaired by the elastomer setting in an abnormal position.

(iii) Instructions for proper storage of emergency respirators, such as gas masks and self-contained breathing apparatus, are found in "use and care" instructions usually mounted inside the carrying case lid.

(g) *Identification of gas mask canisters.* (1) The primary means of identifying a gas mask canister shall be by means of properly worded labels. The secondary means of identifying a gas mask canister shall be by a color code.

(2) All who issue or use gas masks falling within the scope of this section shall see that all gas mask canisters purchased or used by them are properly labeled and colored in accordance with these requirements before they are placed in service and that the labels and colors are properly maintained at all times thereafter until the canisters have completely served their purpose.

(3) On each canister shall appear in bold letters the following:

(i)—

Canister for _____
(Name for atmospheric contaminant)
or

Type N Gas Mask Canister

(ii) In addition, essentially the following wording shall appear beneath the appropriate phrase on the canister label: "For respiratory protection in atmospheres containing not more than _____ percent by volume of _____."
(Name of atmospheric contaminant)

(iii) [Revoked]

(4) Canisters having a special high-efficiency filter for protection against radionuclides and other highly toxic particulates shall be labeled with a statement of the type and degree of protection afforded by the filter. The label shall be affixed to the neck end of, or to the gray stripe which is around and near the top of, the canister. The degree of protection shall be marked as the percent of penetration of the canister by a 0.3-micron-diameter dioctyl phthalate (DOP) smoke at a flow rate of 85 liters per minute.

(5) Each canister shall have a label warning that gas masks should be used only in atmospheres containing sufficient oxygen to support life (at least 16 percent by volume), since gas mask canisters are only designed to neutralize or remove contaminants from the air.

(6) Each gas mask canister shall be painted a distinctive color or combination of colors indicated in Table I-1. All colors used shall be such that they are clearly identifiable by the user and clearly distinguishable from one another. The color coating used shall offer a high degree of resistance to chipping, scaling, peeling, blistering, fading, and the effects of the ordinary atmospheres to which they may be exposed under normal conditions of storage and use. Appropriately colored pressure sensitive tape may be used for the stripes.

[Section 1910.134(g)(3)(iii) revoked at 43 FR 49726, October 24, 1978, 1978, effective November 24, 1978]

TABLE I-1

Atmospheric contaminants to be protected against	*Colors assigned*[*]
Acid gases	White.
Hydrocyanic acid gas	White with ½-inch green stripe completely around the canister near the bottom.
Chlorine gas	White with ½-inch yellow stripe completely around the canister near the bottom.
Organic vapors	Black.
Ammonia gas	Green.
Acid gases and ammonia gas	Green with ½-inch white stripe completely around the canister near the bottom.
Carbon monoxide	Blue.
Acid gases and organic vapors	Yellow.
Hydrocyanic acid gas and chloropicrin vapor	Yellow with ½-inch blue stripe completely around the canister near the bottom.
Acid gases, organic vapors, and ammonia gases.	Brown.
Radioactive materials, excepting tritium and noble gases.	Purple (Magenta).
Particulates (dusts, fumes, mists, fogs, or smokes) in combination with any of the above gases or vapors.	Canister color for contaminant, as designated above, with ½-inch gray stripe completely around the canister near the top.
All of the above atmospheric contaminants	Red with ½-inch gray stripe completely around the canister near the top.

[*]Gray shall not be assigned as the main color for a canister designed to remove acids or vapors.

NOTE: Orange shall be used as a complete body, or stripe color to represent gases not included in this table. The user will need to refer to the canister label to determine the degree of protection the canister will afford.

[Sec. 1910.134(g)(6)]

910.135 Occupational head protection.

Helmets for the protection of heads of upational workers from impact and netration from falling and flying obts and from limited electric shock and n shall meet the requirements and cifications established in American tional Standard Safety Requirements Industrial Head Protection, Z89.1-9.

910.136 Occupational foot protection.

afety-toe footwear for employees ll meet the requirements and specitions in American National Stand- for Men's Safety-Toe Footwear, .1-1967.

910.137 Electrical protective devices.

ubber protective equipment for elecal workers shall conform to the reements established in the American ional Standards Institute Standards pecified in the following list:

Item	Standard
ber insulating gloves.	J6.6-1967.
ber matting for use ound electric paratus.	J6.7-1935 (R1962).
Rubber insulating blankets.	J6.4-1970.
Rubber insulating hoods.	J6.2-1950 (R1962)
Rubber insulating line hose.	J6.1-1950 (R1962)
Rubber insulating sleeves.	J6.5-1962.

§ 1910.138 Effective dates.

(a) The provisions of this Subpart I shall become effective on August 27, 1971, except that:

(1) Any provision in any other section of this subpart which contains in itself a specific effective date or time limitation shall become effective on such date or shall apply in accordance with such limitation; and

(2) If any standard in 41 CFR Part 50-204, other than a national consensus standard incorporated by reference in § 50-204.2(a)(1), is or becomes applicable at any time to any employment and place of employment, by virtue of the Walsh-Healey Public Contracts Act, or the Service Contract Act of 1965, or the National Foundation on Arts and Humanities Act of 1965, any corresponding established Federal standard in this Subpart I which is derived from 41 CFR Part 50-204 shall also become effective, and shall be applicable to such employment and place of employment, on the same date.

§ 1910.139 Sources of standards.

Sec.	Source
1910.132	41 CFR 50-204.7.
1910.133(a)	ANSI Z87.1-1968. Eye and Face Protection.
1910.134	ANSI Z88.2-1969, Standard Practice for Respiratory Protection.
1910.134 Table I-I.	ANSI K13.1-1967, Indentification of Gas Mask Canister.
1910.135	ASNI Z89.1-1969, Safety Requirements for Industrial Head Protection.
1910.136	ANSI Z41.1-1967, Men's Safety-Toe Footwear.
1910.137	ANSI Z9.4-1968, Ventilation and Safe Practices of Abrasive Blasting Operations.

§ 1910.140 Standards organizations.

Specific standards of the following organization have been referenced in this part. Copies of the referenced materials may be obtained from the issuing organization.

American National Standards Institute, 1430 Broadway, New York, NY 10018.